First Lessons in Physiology

HUTCHISON

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FOR

ELEMENTARY CLASSES.

Fully Illustrated.

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BY

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A COMPLETE COURSE

IN

PHYSIOLOGY AND HYGIENE.

BY

JOSEPH C. HUTCHISON, M.D., LL.D.,

Ex-President of the New York Pathological Society; Vice-President of the New York Academy of Medicine; Surgeon to the Brooklyn City Hospital; late President of the Medical Society of the State of New York.

FIRST LESSONS IN PHYSIOLOGY AND HYGIENE.

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Each book in the course complies with the laws requiring instruction in the physiological effects of stimulants and narcotics.

PREFACE.

In this little book the author has endeavored to present in the simplest manner possible such information on the interesting subjects of physiology and hygiene as may be comprehended by the youngest pupil. The statements made are believed to be trustworthy so far as they go. The effects of stimulants and narcotics on the human body have received very careful consideration, and the views presented upon these subjects are believed to be in accord with the latest scientific conclusions. This matter has been distributed through the book, because it is entitled to the same consideration as other subjects pertaining to the health of the body. The book may be read, if not studied, by the younger pupils, preparatory to the study of the author's larger work on Physiology and Hygiene.

CONTENTS.

LIST OF ILLUSTRATIONS.

FIRST LESSONS

IN

PHYSIOLOGY AND HYGIENE.

CHAPTER I.

INTRODUCTION.

1. WHEN we first go into a house where we are to live, if only for a short time, we are anxious to know all about it. We ask about the number of the rooms, their size, how they are furnished, and which we are to have for our own. Our bodies are the houses which our souls inhabit,—houses made for them by God,—which they will occupy while life continues; but, strange to say, we know very little about them. In this little book we shall try to learn something about our bodies, that we may be able to take better care of them, and to keep them strong and healthy.

2. We all know that our bodies are made of flesh and bones. They can move, not like trees and plants, which are moved by the wind, but in obedience to our will. We can go where we "will," or choose to go. We can see, feel, hear, eat, and sleep. These things can be done by the lower animals as well as by man, and seem to us very natural; but when we think about them as something new, or as something to be created anew, how very wonderful they are!

3. Our bodies are always warm, even on very cold days when everything is covered with snow and ice. Why does not the cold affect us as well as the trees and plants? It is on account of the food we eat, which goes into the stomach, and after passing through certain changes, becomes a part of the body, and not only warms it, but repairs the waste, or wear, that is constantly going on.

4. When you prick your fingers or hurt yourself in any way, you feel pain. What causes it? The pain is caused by the irritation of the **nerves**, which are thread-like cords that start from the **brain** and go through every part of the body, even to the ends of the fingers and toes. The nerves are our telegraph-wires, carrying messages to and from the brain, which is the central station. Let us suppose that a flame or a hot iron comes suddenly near the hand, how quickly will the hand be withdrawn, even if we are looking the other way! Some nerve just under the skin telegraphs to the brain the approach of danger, and instantly another nerve brings back a message to take the hand away. Were not the nerves so quick to receive impressions, we should be subject to very serious injuries which we can now avoid.

5. We also "will" to walk, to write, to speak, and our feet, hands, and tongue do what we wish. The brain sends out its orders by the nerves to the muscles which move the different parts of the body, and these good little servants obey them. That part within us which thinks and reasons and wills, we call the mind, and it is this mind which places us above the lower animals.

6. There are a few hard words which we shall be obliged to use in studying about our bodies, and it will be well for us to know the meaning of them before we commence our lessons.

7. We shall first learn about the form and structure of our bodies. The science which tells us about that is called **Anatomy.**

8. We next learn about the uses of the different parts of our bodies. This study is called **Physiology.**

9. The branch of science which tells us how to take care of our bodies, so that we may be strong and live longer than we otherwise would, is called **Hygiene.**

10. The bones of the body put together in their proper places form the **Skeleton.**

11. The red bundles of flesh that, with fat, give form to the body are the **Muscles.**

12. The hair-like cords by which we feel and control the muscles are called the **Nerves.**

13. The body without head, arms, or legs is called the **trunk.** The trunk is divided by a partition, in the form of an arch, called the **diaphragm.** The heart and lungs are in the upper part, which is called the **thorax,** or **chest.**

14. The lower part of the trunk, containing the liver, stomach, intestines, and some other organs, is the **abdomen.**

15. Any part of our body that does the work which belongs particularly to it is called an **organ.** The eye is the organ of sight; the ear, of hearing; and the nose, of smelling. A **function** is the special work of any organ. It is the function of our eyes to see, of our ears to hear, and of our nose to smell.

16. The simplest form of any part of the body is called a **tissue**. The skin is a tissue. There is a fatty tissue, muscular tissue, nerve tissue, and many other kinds of tissues.

17. An organ which makes something out of the blood to be used by the body, or which takes something out of the blood that has ceased to be useful and must pass away from it, is called a **gland**.

18. To keep ourselves in good health so that we may be happy and useful to others, we must know how to keep our bodies and their organs in good order. We must have good food and that which we can digest; but must be careful not to eat more than we can digest easily.

19. We must have plenty of pure air and exercise. We must bathe often, and have clothes that will keep us warm. We must also have plenty of sleep at night. Sleep in the daytime and late hours at night will not give us the rest that we need.

20. Even young people can learn what is best for them, and, by following the directions that will be given them for the proper care of their bodies, may avoid much sickness and save their friends much trouble. These lessons are only a beginning, and will be simple enough for any child to understand. When you are older you will learn more from larger books as well as from experience. Therefore heed all these plain teachings, and believe that Health is one of the best gifts and that much may be done to keep it, as well as, through ignorance and neglect, much may be done to lose it. The Good Book says, "All that

man hath will he give for his life;" and yet life may become almost a burden if health is gone. A long life, a useful life, and a happy life is possible only in the presence of health.

NOTE TO TEACHERS.—The teacher should explain this chapter fully to the class. In studying the following chapters, many helps to the pupils' understanding may be given by obtaining at the butcher's the various organs of an ox or a sheep, and pointing out to the class the parts named in the book. The order in which the subjects of the chapters have been treated is such as the experience of the author has found to be the best. While it has been the purpose to make the text as simple as the nature of the subject would permit, it has been found necessary to anticipate a few of the more common organs, and we trust the teacher to see that they are understood.

QUESTIONS.

1. What are you going to learn about? 11
2. Of what is the body made? 12
3. What is the skeleton? 13
4. What good does our food do us? 12
5. What causes our bodies to feel pain? . . . 12
6. Tell the uses of the nerves. 12
7. Of what use is the brain to the body? . . . 12
8. What does anatomy teach us? 13
9. What science teaches the use of the different parts of the body? 13
10. What is the meaning of the word *hygiene?* . . . 13
11. What are the muscles? 13
12. Where is the chest? Give another name for it. . . 13
13. What do we mean by an organ of our body? . . 13
14. What do we call the simplest form of any part of our body? 14
15. What is a gland? 14
16. What must you do to keep yourselves well? . . . 14

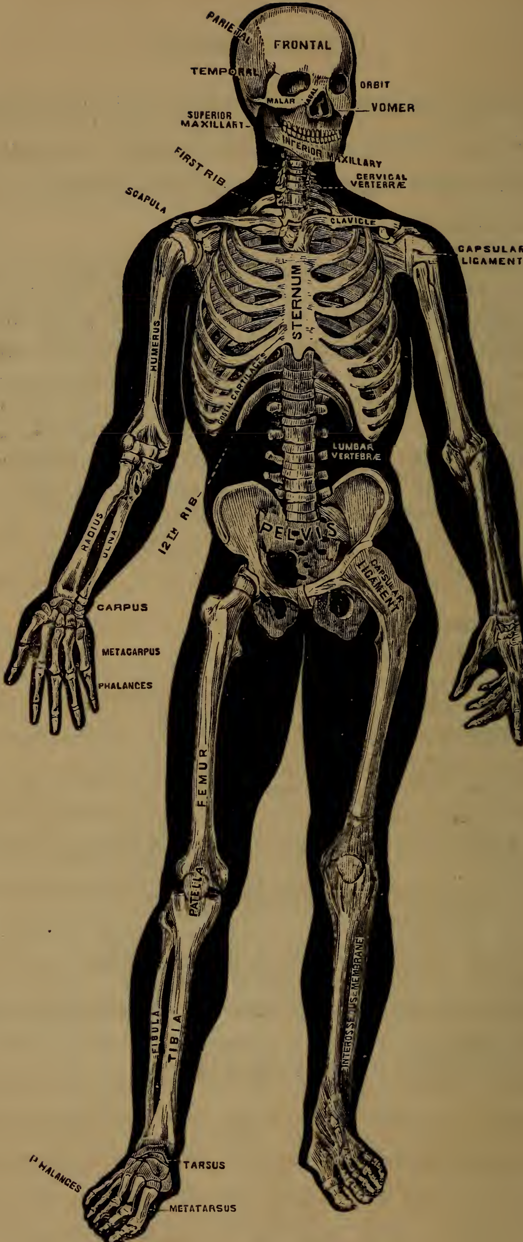

FIG. 1.—THE SKELETON.

CHAPTER II.

The Bony Framework of the Body.

1. **Use of the Bones—The Skull.**—As the beams and rafters of a house keep the walls, ceilings, and floors in place, so the bones keep the soft parts of our body in place, and protect such parts as are easily hurt. The soft brain is protected by the skull which, as it is round and hard, can bear heavy blows.

2. **The Back-bone and Chest.**—The delicate spinal cord lies secure in the long tube-like canal of the back-bone. The lungs and heart are inclosed in a bony box called the *thorax*, or *chest*, formed by the ribs, breast-bone, and the back-bone, or *spine*. The eyes are placed in deep hollows in the skull, as also is the inner ear with which we hear.

3. **Number of Bones.**—There are in the whole body about two hundred bones, large and small. All of these have their names, some of which are short and easy to learn, while others are so hard that they will be left to some future lesson. These bones are fitted together, and, as you have been told, are called the *skeleton*. They can move easily, and without pain to us, when we are in health.

4. **The Size and Shape of the Bones.**—If we look at the picture of a skeleton (Fig. 1) we shall see that the bones differ in size and shape. There are the long bones, like those in the legs and arms; the short bones, like those in the wrists and ankles; and the flat bones, like the shoulder-blade and the knee-cap.

5. **The Structure of Bones.**—If we take a bone of the leg or arm and saw it lengthwise (Fig. 2), we shall see

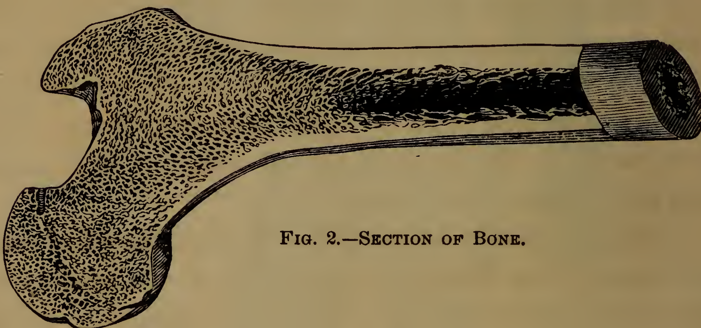

Fig. 2.—Section of Bone.

that, although it is hard on the outside, it is hollow in the middle. This hollow or cavity holds an oily substance called *marrow*. The outside of the bone is full of little holes, through which tiny blood-vessels run, like a network, to the inner part of the bone, to supply it with food.

6. **Strength of Bones.**—You probably think that anything hollow is more easily broken than if it were solid; but we find, by making experiments, that a hollow tube will bear greater weight than the solid cylinder made of the same amount of material.

7. **Substances of which Bones are Made** (Fig. 3).—Bones are made partly of a mineral substance called *lime*, and partly of an animal matter called *gelatine*, which is soft and jelly-like. There is about twice as much lime as gelatine in the bones. If we put a bone into the fire, the gelatine is burned out, and the lime which is left, though it is the same shape as before, is white, and very easily broken. If we put another bone into a mixture of two ounces of muriatic acid and one pint of water, the acid will take the lime away, or dissolve it, as we say, leaving the gelatine; and if the bone is long enough, it can be tied into a knot without breaking.

Fig. 3.—Structure of Bone, enlarged.

8. **Change in Bones.**—As persons get old, they have more lime in their bones; for that reason a very little fall may break them, and when broken they do not unite easily. The bones of children have so much gelatine that they can bear very hard blows without breaking. When broken they have long jagged points like broken chicken-bones, and they unite very quickly. A child has been known to fall from a third-story window to the paved sidewalk without breaking a bone.

9. **The Skeleton** (Fig. 1).—The framework, or skeleton, consists of three important parts: the *skull*, the *trunk*, and the *limbs*. The skull is made, not, as we might suppose, of a single bone, but of eight bones, fitted together like the pieces of a dissected map or pict-

ure. We see it has an oval, or egg-shaped, top, which, as has already been said, makes it very strong. If you squeeze with both hands an egg lengthwise, it is not easy to break it, although its shell is so thin. This is on account of its shape. For the same reason, very hard blows may fall upon the skull, and because the bones are so yielding they will not break, but bend. We have already

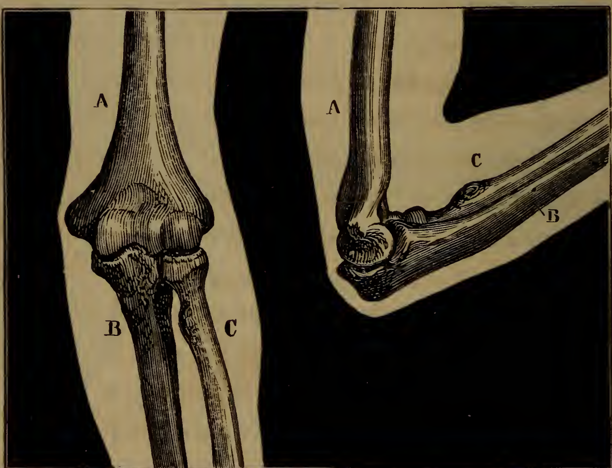

Fig. 4.—Elbow-joint. A, Bone of the arm; B, C, Bones of the fore-arm.

learned that this egg-shaped, yielding skull protects the brain, which is in the top and back part of the head; the eyes, which are sunken in cavities or holes in the front; and, with the bones of the face, the organs of hearing, of smell and of taste. The chest, which is the upper part of the trunk, holds the heart, the lungs, and the great blood-vessels, while the lower part of the trunk holds and protects a variety of important organs. The back-bone, ribs, and hips are the bones of the trunk.

10. The Joints.—The place where the bones meet is

called a joint (Fig. 4). Between the ends of the bones is a thin sac of fluid, called *cartilage*, which looks like the white of an egg. The effect of this fluid on the joints is like oil on the wheels of a carriage. It makes the joints move easily and without noise, and flows only as fast as it is needed. Without these sacs of lubricating fluid, most of the movements of the body would be difficult and painful.

FIG. 5.—THE SPINAL COLUMN.

11. **THE VERTEBRÆ.**—The back-bone extends from the skull to the lower part of the trunk, and is called the spine. If we count the spots in the picture, we find it has twenty-six small bones, called *vertebræ* (Fig. 5), placed one upon the top of the other, and fitted exactly together, much like a string of beads. Each of these bones has a large hole through it, making a tunnel or long tube the whole length. This tube protects the spinal cord, which we shall learn about in another chapter. Projecting from each of the vertebræ are bony knobs to which some of the muscles of the back are fastened.

12. **FLEXIBILITY OF BACK-BONE.** — The back-bone, called the spinal column, is a curious and interesting part of the body to study. It is very flexible and can be curved in many directions with ease and without injury to the spinal cord. Some circus performers can bend their backs until their heads can almost touch their heels.

13. **Strength of Back-bone.**—The back-bone in an erect position is also very firm, and will bear a great weight. We have often seen men and women carry very heavy loads or pails of water upon their heads, which they do not touch with their hands ; yet they seem to walk as easily as any of us do without a load. Boys stand upon their heads and hands, throwing the weight of the body on the bones of the neck and on the skull. While many do this and escape injury, it is not safe or wise to attempt it.

14. **The Cartilage.**—The joints in the back differ from other joints in having thicker layers of gristle, or *cartilage*, between them. This elastic material prevents the brain and other organs from being injured by sudden falls or missteps, and also enables the joints to move easily. The constant pressure upon these joints during the day, by walking, jumping, and other exercise, makes the cartilage thinner, so that a person is not so tall at night as in the morning. If you wish to be as tall as possible, you must get measured in the morning.

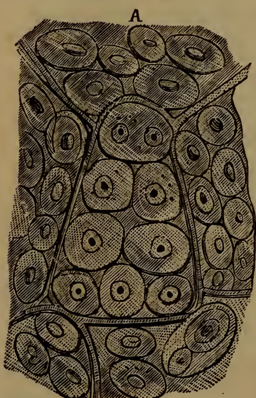

Fig. 6.—Cells of Cartilage.

15. **The Ribs.**—The ribs (Fig. 6) are twenty-four in number, twelve on each side of the spine, and are joined to the breast-bone in front. See how many you can count in your own body. The upper ones are fixed at both ends, the lower ones are free in front, but move when we breathe. This makes the chest like a box with flexible or movable walls for the lungs and other organs, about which we shall study.

16. The Hips and Thighs.—Below the ribs are the hips, which have hollow, cup-shaped cavities into which

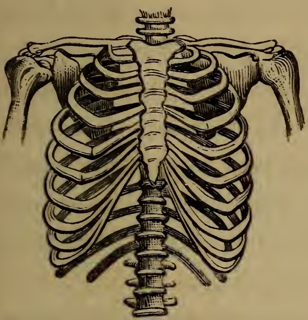

Fig. 7.—Ribs in a Natural and Healthy State.

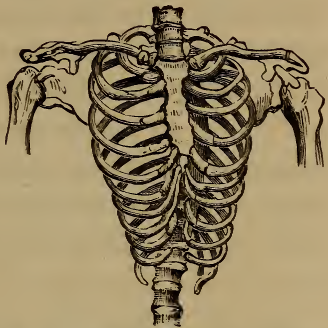

Fig. 8.—Ribs Showing the Effects of Tight Lacing.

the thigh, or upper bones of the leg, so fit that we can move our legs in every direction. At the knee-joint, the thigh-bone and the two bones of the lower part of the leg meet.

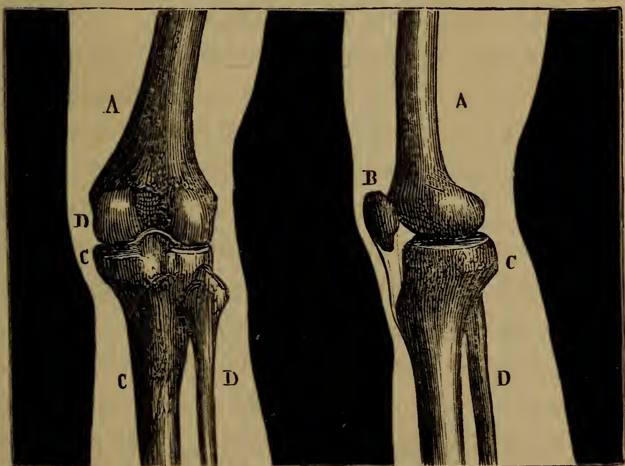

Fig. 9.—View of Knee-joint.. A, Thigh bone; B, Knee-pan; C, D. Leg bones.

17. The Knee-pan.—A flat bone called the knee-pan (Fig. 9) covers the point of union, and is intended to pro-

tect the joint from injury. If you extend the leg, letting the heel rest upon the floor, this movable bone can be easily felt. The knee-pan is often broken or injured by a fall upon the knee when skating or playing.

18. **The Feet.**—The ankle has seven small bones which are bound so firmly together that they can bear the weight of the whole body. There are twenty-six small bones in the foot, which are so joined that the whole foot is elastic, and we are able to run and jump without injuring our feet or any part of our bodies.

19. **The Toes.**—The toes can be made to do work that belongs to the fingers, if the hands are wanting. Persons who have no hands have been known to write well, to paint good pictures, to feed themselves, and, in short, do many things with their toes almost as easily and naturally as we do with our fingers.

20. **The Arms.**—The arms are joined to the upper part of the trunk by the collar-bone and shoulder-blades, which may be easily felt. There is one bone in the arm, which is the part above the elbow, and two in the fore arm, or that part below the elbow. The wrist is formed of eight little bones, strongly held together; and joined to these are the bones of the hand and fingers.

21. **How to Keep the Bones Healthy.**—When children are young, the bones are easily bent, and, being soft, sometimes grow out of shape. If a child is allowed to walk too early, he may become bow-legged. If we wear shoes too tight for us, our toes will be put out of shape, and we are likely to have bunions, or distorted joints, as well as corns. If we bend over our work or desks, in-

stead of keeping an upright position, round shoulders are generally the result. When standing or sitting, throw the shoulders back, hold the head erect, expand the chest, and keep the natural curves of the spine. By following these directions we may avoid the deformities that such habits of stooping are likely to produce.

NOTE TO THE TEACHER.—It would be an interesting exercise if the teacher would ask the pupils to point out on some one of their number the location of the different parts mentioned in this lesson.

QUESTIONS.

1. Compare the bones with the framework of a house. . 17
2. How is the brain protected? 17
3. In what are the lungs and heart inclosed? . . 17
4. How many bones are there in the body? . . . 17
5. Are all the bones the same size and shape? . . 18
6. If you saw a bone in two lengthwise, how does it look? . 18
7. What does the hollow cavity hold? . . . 18
8. What do you find on the outside of the bone? . . 18
9. What is the use of the blood-vessels? . . . 18
10. What are bones made of? Give the proportion. . . 19
11. What happens if you put a bone into the fire? . . 19
12. What happens if you put it into a certain acid? . . 19
13. What are the proportions of the acid and the water? . 19
14. Why do the bones of old people break easily? . . 19
15. Why are the bones of children less easily broken? . 19
16. Of what important parts does the skeleton consist? . . 19
17. How many bones are in the skull? . . . 19
18. What is the shape of the skull? and why is it made so? . 20
19. What are the uses of the skull? 20
20. Describe the chest and its uses. 20
21. What are the bones of the trunk? 20
22. What is a joint? Describe it. 20
23. What is between the ends of the bones, and its use? . 21
24. How many bones has the spine? Describe them. . . 21
25 What is the use of the cartilage? 21
26. When are you tallest? 22
27. How many ribs have you? Describe them. . . 22
28. Where are the hips? What bone do they support? . . 23
29. What bones meet at the kneee-joint? . . . 23
30. What is the knee-pan and its use? 23
31. How many bones has the ankle? 24
32. How many bones has the foot? 24
33. What can the toes and feet do beside enable you to walk? 24
34. How are the arms joined to the trunk? . . . 24
35. How many bones are in the arm? In the wrist? . . 24
36. Are children's bones strong? Give the facts. . . 24
37. What causes bow legs and other deformities? . . 24
38. Will tight shoes hurt you? Why? . . . 24
39. How should you sit when you are studying or working at a desk? and why? 25

CHAPTER III.

The Muscles.

1. **How the Body is Moved.**—We have called the body a house in which the soul dwells. But, as it has the power of motion, it is something more than a house. It is a movable dwelling. We can walk and run, swing our arms, move our eyes, fingers, and toes. All these motions are made by means of the muscles.

2. **The Muscles.**—Take hold of the upper part of the arm and move the fore arm back and forth. You will feel the curious motion of the muscle as the joint is moved. The word muscle means "a little mouse," and is supposed to refer to the sensation produced, as of a small moving body, when the fingers are placed over a muscle in action. This muscle becomes very large and strong in the arm of a blacksmith or of any other person who uses his arms a great deal.

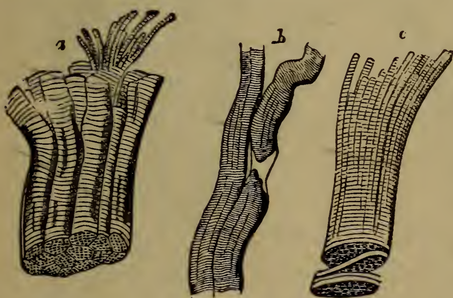

Fig. 10.—Muscular Tissue.
a, *b*, Striped muscular fibers; *c*, The same more highly magnified.

3. The Fibers.—The muscles of the body when exposed to view look like the lean meat of beef. Lean

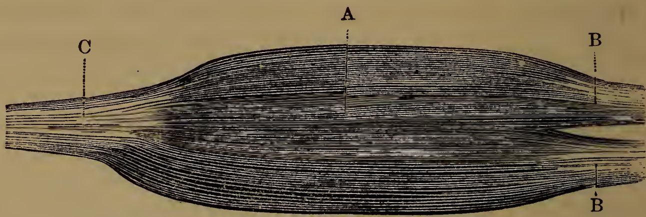

Fig. 11.—A, Biceps muscle of the arm; B, C, Its tendons.

meat of any kind is only bundles of muscles. Under the microscope we see that muscles are composed of fleshy

Fig. 12 shows the muscles and tendons of the hand; A showing the palm, B the back of the hand. These numerous muscles and tendons form a very complicated piece of mechanism, and help to give to the hand its marvelous dexterity and flexibility.

strings (Fig. 10) called *fi-bers.* These are made of still finer fibers called *fi-bril-læ*, which are marked by stripes

or lines. Hence they are called *striped* muscles. These markings cannot be seen without the aid of a microscope.

4. **Tendons.**—When we bend our arms we feel something like a cord at the joint. This cord is called a *tendon* (Fig. 11), and connects the muscle with the bone, so that when the muscle is drawn up the bone also is drawn up. We can feel the tendons in our elbows and knees when we move our muscles; and if we put the fingers of one hand on the wrist of the other, and then open and shut the hand, we can feel the cords or tendons just below the skin (Fig. 12). We find more of them about the joints, particularly the wrist and ankle joints. The muscles in the front part of the thigh unite to form a single and very powerful tendon. This tendon incloses a small bone called the knee-pan, of which we spoke in the last chapter, and which increases the power and also protects the knee-joint.

Fig. 13.—Lower Portion of the Leg.

5. **Tendon of Achilles.**—The largest tendon in the body is that which goes into the heel and is called the tendon of Achilles (Fig. 13), after a Greek hero of that name. The story is that the water of the mythical river Styx was said by the ancients to cause any person who bathed in it to be invulnerable; that is, he could not be wounded. When Achilles was a baby, his mother, wishing to prevent his early death, held him by the heel and

FIG. 14.—THE MUSCLES.

dipped him into the river. The heel she held him by was not wet by the water, and it was in that place he received his death-wound.

6. **Contraction of the Muscles.**—When we bend our arms, as boys do when they "try their muscle," as they say, we feel the arm "swell out." This is because the muscle contracts in length, and grows thicker.

7. **Two Kinds of Muscles.**—There is no muscle that does not move some part of our bodies. Muscles are divided into two classes: *voluntary* and *involuntary*. The voluntary muscles are used when we wish or "will" to move a part of the body, as our hands or feet. Voluntary action depends on the brain.

8. **Involuntary Muscles.**—The involuntary motions, like the beating of the heart, or the breathing, do not depend on the brain. The muscles that control them act when we are asleep or when the mind is at rest, as well as when we are awake and active. If these muscles were dependent on the will, we should die as soon as we fell asleep. How unhappy we should be if, in order to live, we had to think all the time about the beating of our hearts, or of our breathing! And what terror we should be in, lest we should fall asleep and forget to breathe!

9. **Exercise.**—To keep our bodies in health we must take exercise, but not too much or at the wrong time. Violent exercise continued too long does harm instead of good. We may by this means get large muscles at the expense of health and strength.

10. **When to Exercise.**—We should not take much

exercise before breakfast. The best time for exercise is two hours after eating. Out-door exercise is the most beneficial. Children love to run and jump, and it is a good thing for them if they do not carry it to excess, like the little girl who tried to jump the rope longer than any of her companions, and fell dead.

11. How to Exercise.—Walking rapidly is a good exercise also, as all the muscles are then used; but walking

Fig. 15.

slowly, or "poking" along, as we call it, does very little good. Children ought to enjoy their play, and enter into it with all their hearts in order to get the full benefit of the exercise they are taking. Rowing, climbing, skating, and swimming are all good and healthy exercises; in short, any open-air exercise that will interest us and divert our minds, if it is not too violent, will be the best for us.

12. Gymnastics.—Gymnastic exercises, as with dumb-bells, clubs, and swinging by the hands from cross pieces of wood, if practiced carefully and not too many minutes at a time, are also good exercises. One of the simplest arrangements for strengthening the muscles of the back is one that any child can put up. Screw two hooks into the wall or door-post, a little distance apart; to them fasten two India-rubber cords with wooden handles (Fig. 15). Pull the cords with the right hand, or the left hand, or with both hands at once. Another way of exercising is to screw into the floor a hook to which are attached two elastic cords with handles, the cords being so short that you must stoop to reach them. Pull the cords up as far as you can, and let them go back slowly as far as they will go, so that you must stoop again. This exercise may be continued for several minutes with great benefit.

Young folks love to arrange these things for themselves.

QUESTIONS.

CHAPTER IV.

The Skin.

1. **Nature of the Skin.**—The skin is the outer covering of the body. It is thin, soft, and elastic, and, though constantly wearing, is constantly renewed. There are two layers which form the skin. The outer layer is called the *cuticle*, or scarf-skin; the inner layer is the *cutis*, or true skin.

2. **The Scarf-skin.**—The scarf-skin is formed by layers of little flakes or scales, which are constantly drying and falling off as other layers form, and this keeps the skin soft. What we call "dandruff," which appears like dust in the hair, is nothing but these worn-out flakes. There is no feeling in the scarf-skin. If we run a pin or a needle under it, as children often do, we do not feel any pain.

3. **Where the Scarf-skin is Thickest.**—The scarf-skin becomes thicker and harder over those parts of the body which are most used, as the soles of the feet and the palms of the hands. When persons use their hands to do hard work, like digging in the ground, laying brick, or cutting wood, the scarf-skin becomes very thick, or "horny," as we say.

4. **Worn-out Skin.**—If we take any garment that has been worn next the skin, during the day, and shake it, something will fall from it in very small scales that looks like dust. This is the scarf-skin, which has been worn out and has fallen off, leaving the new skin in its place. Snakes also shed their skins, but all in one piece. They crawl out of them, leaving them in the woods or fields, where boys sometimes find them.

5. **The True Skin.**—The true skin lies beneath the scarf-skin. It is very sensitive and well supplied with blood-vessels. If we prick the finger or cut deeply into the cutis, or true skin, the blood comes, and we feel pain. If the cutis is destroyed by a burn or deep cut, a scar is made which will last all our lives.

6. **The Nails.**—The nails grow out from the skin near the ends of the fingers and toes, and serve to protect them. Below the skin which covers the lower part of the nail is the root. The nail, if lost, will grow again in a short time, if the root is not injured. We can see how rapidly the nails grow by marking one near the root. Little by little the mark will advance until it reaches the end of the finger-nail.

7. **Care of the Nails.**—We should never bite the nails, as it injures the sense of touch and gives to the ends of the fingers an ugly shape. Trim the nails with scissors, but not too closely. Never scrape them with anything hard, as it will injure the polish. Push the skin back carefully about the lower part, near the root, with something blunt. This will prevent *hang-nails* which we sometimes find so troublesome.

8. **The Hair.**—The hair (Fig 16), like the nails, grows out of the skin. Each hair grows from a little sac or pocket in the true skin. This sac is filled with oily matter, which keeps the hair moist and glossy. To keep the scalp clean, the hair should be well brushed, and occasionally washed.

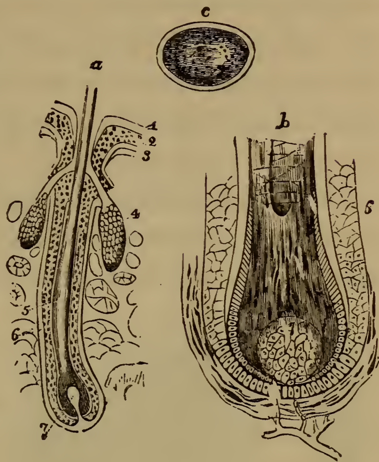

Fig. 16.

a, *b*. The Root of a Hair, highly magnified.

1, 2, 3. The skin forming the hair sac. 4. Sebaceous glands. 5. The hair sac.

c. Transverse Section of a Hair highly magnified.

9. **The Color of the Hair.**—The color of the hair is given to it by coloring matter with which little sacs in the layer of the true skin are filled. When these sacs begin to dry up, as when people grow old, or from some other cause, the hair turns gray. Sometimes a sudden fright or a great sorrow has been known to turn the hair white in a few hours.

10. **Perspiration, or Sweat.**—Our skin is full of little holes called *pores*, each of which is the opening of a tube called a sweat-gland (Fig. 17). These tubes are about a tenth of an inch long, and there are so many of them, that if all the sweat-glands of the body could be joined into one tube, it would be over three miles long.

11. **Use of Sweat-glands.**—Of what use are these sweat-glands? There is a good deal of matter in our bodies

that has been used up and must be got rid of. Much of it is carried off in the form of vapor, which we cannot see. This is called *insensible* perspiration. That which shows in drops on the face and body is called *sensible* perspiration. About two pints of moisture come through these little pores every day.

12. Effect of Closing Sweat-glands.—When the pores are closed, as has been sometimes done by covering the skin of animals with a coating of varnish, death will take place. At the coronation of one of the Popes, about two hundred years ago, a little boy who was to act the part of an angel was covered from head to foot with a coating of gold-leaf. He soon became sick, and although every remedy was tried, except removing the gold-foil, he died in a few hours. Smallpox is a very fatal disease among the American Indians, and it is supposed to be so because they cover their bodies with paint and bear's grease, which close the pores of the skin and stop the perspiration.

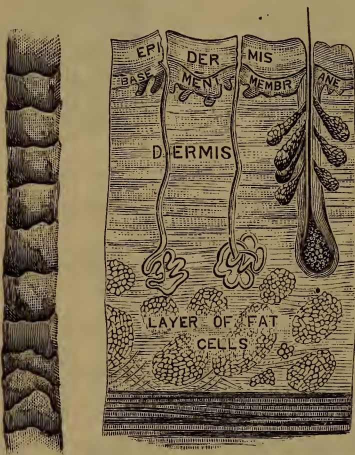

Fig. 17.—Showing a Hair and Section of Skin with Sweat-gland, highly magnified.

13. Bathing.—Our health depends very much on keeping the skin clean. The little pores, or drain-pipes, which carry off matter that is injurious to the body, must not be stopped up. Suppose that the drain-pipes which

carry off the dirty water and other impurities from our houses should be closed, so that nothing could escape; what a dreadful state our houses would be in, and how soon we should be sick! It is even more important for us to keep the skin clean and the pores open by frequent bathing.

14. **The Sponge-bath.**—When we first get up in the morning, a bath in cold water is very refreshing. If a bath-tub is not convenient, a basin of water and a sponge will answer the purpose. After a cold bath, brisk rubbing is necessary to get the body warm. Besides the impurities thrown off from our bodies by perspiration, the skin, as we have seen, is constantly wearing out and rubbing off.

15. **Effect of Bathing.**—The skin comes off in such small scales that we can hardly see it, but bathing helps to remove it. We notice this when we bathe in hot water and rub the body hard. The dead skin, which is softened, rubs off in little rolls. If we look at the cold water we have used without soap, and then at the hot water we have used with soap, we can readily see which will remove the dirt most thoroughly. Did you ever notice how your pet birds enjoy a bath, even in the very small dishes put into their cages? They lie down in the water, and throw it on to their backs, that they may get wet all over. After a rain the birds get into the water that is in the hollows of the streets or yards and wet themselves thoroughly. When that is done they are ready to arrange their feathers. Boys and girls would do well to imitate the example of the birds and bathe

themselves well before they dress. Fine clothes ought never to cover an unclean body.

16. **"The Three Greatest Physicians."**—When one of the most distinguished physicians of Paris lay on his death-bed, the doctors who were attending him were expressing their deep regret that he was so soon to die. "Gentlemen," he said, "do not regret me. I leave behind me three of the greatest physicians." On their urging him to give the names, each one thinking that his own name might be among them, he briefly added, "Water, exercise, and diet." No epidemic can resist clean houses, clean air, and clean water.

17. **Clean Clothes.**—It will be seen, from what has been said about perspiration and the skin, that our clothes must be clean as well as our bodies. The waste matter that is constantly thrown off gets into the clothing that is worn next the skin; and if our clothes are not changed frequently, they will become unpleasant to those about us. We shall feel uncomfortable ourselves, although we may not know why.

18. **Pleasure in Cleanliness.**—After traveling all day or all night in a railroad car, the best thing we can do, to rest and refresh ourselves, is to take a bath, and put on clean clothes. It is even more refreshing than food. White clothes worn next the skin are better than those that are colored, as the white ones show the dirt and we are more likely to have them washed. Colored clothes worn next the skin should be washed as often as white ones.

19. **Danger in Uncleanliness.**—The Bible is very particular to lay down rules for cleanliness; Moses gives

laws concerning it to the Israelites. David writes of clean hands and a pure heart. Washing the feet of a guest, and washing the hands before eating, were rules that were strictly observed in the time of Christ. Mr. Charles Kingsley says that when the civilization of Egypt, Greece, and Rome faded, the world passed through the dark ages of mental and physical barbarism. For a thousand years there was not a man or woman in Europe that ever took a bath. No wonder that the terrible epidemics we have read of swept off the people by thousands.

20. The Sick-bed.—Clean clothes and clean bed-linen are very refreshing to the sick. The clothing becomes soiled by what is thrown off the body, and clean linen gives the patient a feeling of rest and comfort that he can get in no other way. Clean clothes, with plenty of pure air and sunlight, are often the best medicines. We should never sleep at night in the clothes we have worn during the day. Beds and bedclothes should be exposed daily, if possible, to light and air.

21. Change of Clothing.—Our clothing should always be thick enough to keep our bodies warm. Flannels should be worn next the skin to keep us from taking cold. It is far easier and better to prevent a cold than to cure one, as any person who has tried it knows. Never allow wet or damp shoes, stockings, or skirts to dry while on you. Get home as soon as possible and put on warm and dry ones. Also rub the skin thoroughly until a glow is produced. Outside wraps should, if possible, be removed whenever we go into a warm room to remain, and should be put on again only when we are ready to go into the air. We cannot be too careful about these things.

QUESTIONS.

1. What is the skin? Describe it. 35
2. How many layers has it? 35
3. What is the name of the outer layer? . . . 35
4. How is it formed? Is there any feeling in it? . . 35
5. What makes it thick and hard? 35
6. If you cut your finger why do you feel pain and draw blood? 36
7. How do you know that you shed your skin? . . 36
8. How do snakes shed their skins? 36
9. What is the cutis? What happens if you injure it? . 36
10. Describe the nails. Where is the root? . . . 36
11. How should you care for your nails? . . . 36
12. How does your hair grow? 37
13. What is the use of the hair-sac? 37
14. What gives the hair its color? 37
15. What causes the hair to turn gray? . . . 37
16. What are the pores of the skin? 37
17. If these sweat glands were joined together lengthwise, how long would the tube be? 37
18. Of what use are these glands? 37
19. What is insensible perspiration? 38
20. What is sensible perspiration? 38
21. How much moisture comes through the pores of the skin daily? 38
22. When the pores are closed what happens? . . . 38
23. Tell the story of the boy angel. 38
24. Why is small pox so fatal among Indians? . . . 38
25. Why is it important to keep the skin clean? . . 39
26. Is a cold bath good for you? Why? . . . 39
27. Is it necessary to change your clothes often? Why? . 40
28. What does the Bible say about cleanliness? . . . 40
29. What can you say about clean bed clothes? . . 41
30. Should you wear the same clothes next your skin day and night? Why not? 41
31. Should you wear wet shoes and clothes? . . 41

CHAPTER V.

Food and Drink.

1. **Why we Need Food.**—During life our bodies are constantly wearing out. We run, play, talk, and walk. These movements, as well as many others, wear out the body. Yet we may feel and look as well to-day as we did yesterday, perhaps better. We grow tall and strong, yet do not feel tired and worn out. What is the reason for this? What have we been doing besides playing and working? We have been eating our three meals every day, and this food, together with the air we breathe, makes up for the waste in our bodies. The bones, muscle, brain, and other parts of the body get from the food we eat what each needs to keep it in good working order.

2. **Hunger.**—We all know that if we go without food for a longer time than usual, we first feel hungry, then faint and weak; and if we can get neither food nor drink for a long time we shall die of starvation. It is said that a person can live only about seven days without food and drink, but about twenty if he has water alone, although there are cases spoken of where men have lived without either food or drink a much longer time.

3. **Quantity of Food.**—The quantity of food that a

person needs to sustain life depends on his age, and also on the kind of life he leads. Those who are very active and live much in the open air require more food than those who sit while they are working or who study a great deal. Children generally require more food than grown persons, as they need not only to repair the waste of their bodies, but to supply materials for their growth. A healthy man needs every day about six pounds of food and water. Those who live in cold climates need more food than the inhabitants of hot climates, because food keeps the body warm. As persons get old, they have less appetite, and the repairs do not take place as they did in earlier life. Hence aged persons waste away, become thin, and have a wrinkled look. We sometimes hear it said that a person has died of old age. That is, his food did not nourish his body sufficiently to keep him alive.

4. **Water.**—Strange as it may seem to some of us, water is the most important article of food. We can live much longer without solid food than without water. Why is this? Because about two-thirds of all the matter in our bodies is water. It is found everywhere, even in the bones and teeth. Water helps to change our food into blood by dissolving or melting it in the stomach, as we melt sugar in water.

5. **Water in Fruits.**—Water comprises a large part of our fruits and vegetables. Therefore, if we can get juicy fruits we can do very well for a long time without water. We lose a great deal of water every day (nearly two quarts) through the skin, the lungs, and kidneys, of

which we shall learn more. This waste must of course be supplied, and this is why we need so much water or watery food every day.

6. **Pure Water.**—It is very important to have our drinking-water pure. If it is not, the dirt and impure matter that it contains will injure us. Rain-water is the purest water in nature; but even that, in falling through the air, catches the particles of dust that are constantly carried up from the ground into the air, and brings them down again.

7. **Well-water.**—Well-water that is sparkling is usually the most impure water we have, though persons generally think it is the best. It takes up from the ground gases made from decaying vegetable or animal matter, and these gases give to it the beautiful sparkle. Spring-water is much better than well-water, unless the well is far away from or very much higher than barns or out-buildings, from which impurities are constantly soaking into the ground, and are thus carried to the water in the wells. If there is any doubt about the purity of drinking-water, it is best to boil it. In that way the impurities become harmless. Distilled water can be had in large cities and is very pure. Good filters will take impurities from the water, and make even muddy water quite clear.

8. **Common Salt.**—Salt is a common article of food, and is used by all nations and in all climates. When it is obtained with difficulty, it will bring almost any price. On the gold coast of Africa, where salt is scarce, a handful of it will buy one or two slaves. The lower animals as

well as man love it. Farmers know that it is good for their cows and sheep, and feed it to them. If it is taken away from them, the hide grows rough and the hair falls out. Without it they cannot digest their food well, and often starve to death. Wild animals will go for it a long distance to the salt-licks or salt-springs.

9. **Vegetables.**—Vegetables contain salts of potash, which we need to keep the blood pure. Sailors and other persons who cannot get fresh vegetables for a long time suffer from a dreadful disease called *scurvy*. When a long voyage is to be made to countries where there are no fresh fruits or vegetables to be had (like the voyage of Dr. Kane to the Arctic regions), a good many onions and potatoes are taken, and are very useful in keeping off the disease. In one of Dr. Kane's reports he said that he had just had two potatoes grated to give to a man who was very ill with scurvy. We need salts of lime to make our bones hard and strong, and this we get from meat, milk, and bread.

10. **Iron.**—Iron helps to make good blood and to give to it its bright-red color. Iron is found in many of the foods we eat. When persons get very pale, it is a sign that their blood does not contain iron enough. It is often given in some form by physicians as a medicine.

11. **Flesh-producers—Eggs.**—Eggs are an excellent article of diet. The egg is two-thirds water, the rest is albumen and fat. The fat is in the yolk, and gives it its yellow color. The white of an egg is nearly all albumen and water. Soft-boiled eggs are more easily digested than those that are hard-boiled or fried.

12. **Meat and Milk.**—Animal food or meat has a great deal of albumen and fat. Beef and mutton are better for food than veal or pork. There is considerable fat in milk, as we see when we remember that butter is made from it. Milk is the simplest, and for many persons the best, article of food. No other single thing will sustain life so long. It has been called the "model food."

13. **Fats.**—Fats or oils are the great heat-producers. We all know how quickly fat burns when put on the fire; this is a chemical process, and it is a similar process which causes heat when our blood comes in contact with the fatty food we eat. Fat burns in our bodies very much as it does in the fire, only not so fast, and is really fuel food, or food to warm us. Some of you may not like fat, but you can learn to eat it and in time become very fond of it.

14. **Climate and Food.**—People who live in cold climates eat a great deal of fat in order to make heat for their bodies, so that they can bear the intense cold. The Esquimau eats every day ten or fifteen pounds of blubber, which is the fat of whales, and the children drink oil and eat tallow-candles with as much relish as our children eat ice-cream or candy. As persons get old, their bodies do not produce as much heat as when they were young, and, although they may be wrapped in flannels, they will still be cold. A bottle of hot water or a hot brick or iron is sometimes necessary in order to produce warmth.

15. **Sugars and Starches.**—Sugars and starches are also heat-producers. They possess a good deal of carbon, which is known in another form as charcoal. This car-

bon unites with the oxygen of the blood and produces heat. There is some sugar in wheat, and a good deal in honey, milk, and the sweet fruits, such as grapes, pears, peaches, and cherries. Sugar is very easily digested if not taken in excess. Starch is found in wheat, corn, and all other kinds of grain, as well as in potatoes, arrowroot, and sago. Starch must be changed into sugar by digestion before it can be useful in nourishing the body. The saliva, the fluid formed by the glands of the mouth, changes the starch into sugar, thus making good food.

FIG. 18. GRANULES OF POTATO STARCH, MAGNIFIED.

16. ALBUMEN, FAT, AND SUGAR.—Unripe fruits contain starch which, during the process of ripening, is turned into sugar. Such fruits are indigestible when eaten raw or uncooked. Children often make themselves ill by eating green apples or peaches and other unripe fruit. Albumen, fat, and sugar are all necessary to sustain life. An animal can be starved to death if we feed him for a long time on nothing but the white of eggs, or butter or sugar. But mix these together and the animal will live and thrive. Bread made from wheat flour contains nearly everything, except fat, that is necessary to keep us alive. The butter gives the fat, so that bread and butter make an almost perfect food.

The locusts and wild honey eaten by John the Baptist contain the three elements also.

17. **Tea and Coffee.**—Tea and coffee are stimulants rather than food, and if not used in too large quantities seldom do harm to grown people. They should never be used by any one to take the place of real food. Women who work hard often eat very little, but drink a great deal of strong tea. This habit causes indigestion and loss of strength, and if long continued will ruin the health. Boys and girls should never drink tea or coffee. They do not need stimulants. Pure water and milk are better for them than anything else they can drink.

18. **Alcohol.**—When the juice is first pressed out of apples it is sweet to the taste and will do us no harm. If it stands for a few days where it is warm, it begins to ferment or "work," as we say, and loses its sweet taste. If we put new cider into bottles, cork the bottles tightly, and let them stand some time, we find, when the corks are drawn, that a gas escapes with a pop and causes the cider to sparkle and foam. This is called *carbonic-acid gas.* The sugar in the apples has changed into carbonic acid and also into alcohol.

19. **Fermentation.**—Corn, wheat, barley, and other grains, if kept warm and moist, are changed into alcohol in the same manner as the apples. This process of changing is called fermentation. By heating the fermented liquor the alcohol is driven off in the form of vapor. This vapor is cooled and makes a strong liquor.

20. **From What Alcohol is Made.**—Alcohol is made from whiskey, gin, rum, etc.; whiskey, from corn and

rye; gin, from barley and rye. Rum is made from molasses. If people begin to drink these things they grow to like them, and a thirst is created for them which causes drunkenness. You have all seen men drunk and know how they look and act. Do you want to be like them? If not, never touch intoxicating drinks. Physicians sometimes give them to sick persons as medicine. Taken in that way they sometimes do good, just as other medicines may help to cure you when you are sick.

21. **Alcoholic Drinks.**—Wine, whiskey, brandy, beer, ale, and porter contain alcohol. Alcohol takes up a great deal of water. Your body also requires a large quantity of water, and when alcohol is taken into the stomach it mixes with the water and creates thirst rather than relieves it. Some alcoholic drinks appear to quench the thirst, but it is because they contain a great deal of water. How much better it is to take water in its pure state!

22. **Alcohol Weakens.** — Many persons think that when they have hard work to do they will feel stronger and better able to accomplish it by using alcoholic drinks. We find, however, by experiments which have often been made, that this is not the case. The feeling of strength which is given by the alcohol lasts only for a short time, when more is required. The more a man drinks the more he wants, until his stomach is inflamed, its walls are thickened, and the circulation of the blood is deranged. His mind is weakened; he cannot do his work well; his hands tremble, and his body refuses to do his will. If, instead of spending money for whiskey, men

would be satisfied to buy good food, would quench their thirst with water, and use tea and coffee, which are slight stimulants, they would be better able to work and far more healthy and happy.

23. Does Alcohol Produce Heat?—Men who are accustomed to alcoholic drinks feel the cold more than those who do not use them. The soldiers who served in Napoleon's campaign in Russia found that they could bear the intense cold better without alcohol than with it. The British soldiers who served in the recent war in the Soudan endured hardships in that hot country better without the use of alcohol in any form. Men who have spent much time in the Arctic regions have found that the use of alcohol unfitted them to resist the intense cold. They were obliged, like the natives of those regions, to eat plenty of fat and avoid alcohol.

QUESTIONS.

CHAPTER VI.

Digestion.

1. **Why We Eat.**—In the last chapter we learned about different kinds of food and drink,—what kinds are good for us, and what kinds are not. We eat meat, bread, butter, milk, and vegetables to nourish the body. These things do not look much like our bodies, do they? How, then, are they all so wonderfully turned into flesh, bones, blood, and muscles? We call the process by which this change is made digestion. Digestion takes place in the stomach and intestines, where the food is softened and is made fit to be taken into the blood to furnish nourishment for the body.

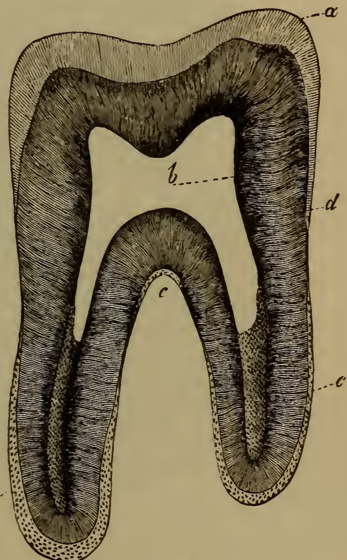

Fig. 19.—Section of a Tooth.
a, Enamel; *b*, Cavity; *c c*, Roots; *d*, Body of the Tooth.

2. **Mastication, or Chewing.**—As soon as the food is taken into the mouth it is cut into very small pieces by the teeth. In chewing, the movements are made by the lower jaw, the upper jaw having no motion.

3. **The Teeth.**—(Figs. 19 and 20.) The teeth are hard, white, bone-like bodies, held in place by roots running deeply into the jaw. The exposed part, or "crown," is

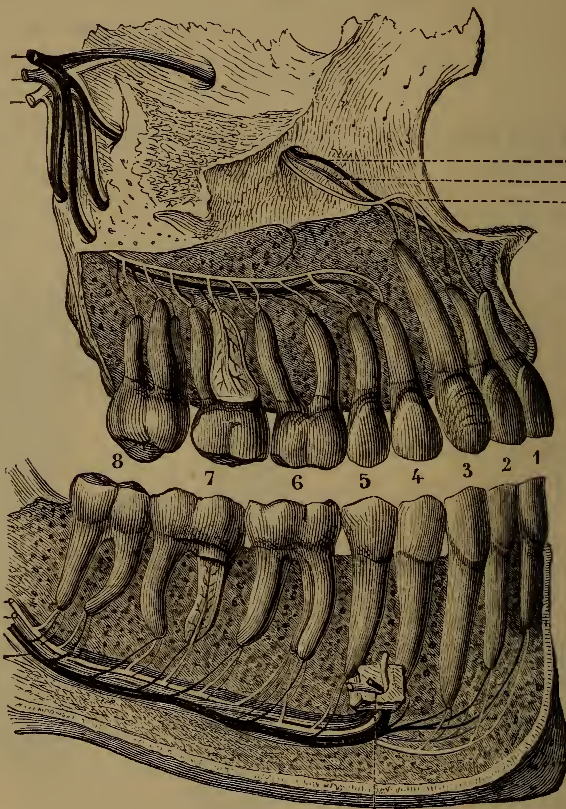

Fig. 20.—Section of the Jaws—Right Side.

V, A, N, Veins, Arteries, and Nerves of the Teeth. The root of one tooth in each jaw is cut vertically to show the cavity and the blood-vessels, etc., within it. 1 to 8, Permanent Teeth.

protected by a thin covering of enamel which looks like ivory. It is the hardest substance in the body and is capable of striking fire with steel. The middle of each

tooth is hollow, containing blood-vessels and nerves, which enter through a very small opening at the root (Fig. 19).

4. **Number of Teeth.**—There are two sets of teeth. Those of the early part of childhood are called the milk-

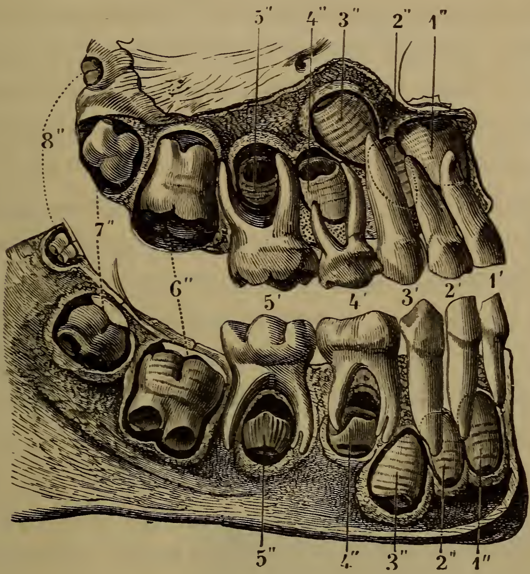

Fig. 21.—Section of the Jaw.
1′, 2′, 3′, 4′, 5′, the Milk-teeth; 1″ to 8″, the Germs of the Permanent Set.

teeth. They are twenty in number and small. At six or eight years of age, when the jaw grows larger, the milk-teeth begin to fall out to make room for the second set (Fig. 21). There are thirty-two teeth in the permanent set, an equal number in each jaw.

5. **Kinds of Teeth.**—The front teeth are small and sharp for cutting the food. They are called *incisors*. They are eight in all, two on each side of each jaw.

These teeth are well shown in gnawing-animals, like rabbits, squirrels, and rats. The *canines*, also called the eye and the stomach teeth, stand next, one on each side of the jaw. They resemble the long pointed tusks of the dog. The *bicuspids* are next in order, four in each jaw. Behind them are the regular *molars*, or *grinders*, six in each jaw. They do the hardest work, crushing or grinding the food. The last molars are called the *wisdom-teeth*, because they do not usually appear until after a person is twenty.

6. Care of Teeth.—The teeth should be brushed after eating to remove the food that has adhered to them. The enamel, if once destroyed, is never formed again, and the teeth are likely to decay. On this account we should be careful to avoid biting hard substances that will break the enamel. Children often crack nuts with their teeth. This should never be done.

7. The Saliva.—When we are hungry and see or smell anything nice to eat, a watery fluid comes into the mouth, or, as we say, the "mouth waters." This fluid, or *saliva*, comes from little spongy organs called the salivary glands, six in number, situated near the mouth

Fig. 22.—Structure of a Salivary Gland.

by little tubes (Fig. 22). They resemble bunches of

grapes with tubes for stems and stalks. The flow from these glands is at all times sufficient to keep the mouth moist; but when we are eating, the saliva pours forth freely.

8. **Use of Saliva.**—Saliva moistens the food so that it can be easily swallowed. By dissolving substances, like sugar and salt, it gives us their peculiar taste. Saliva has also the power of changing starch into sugar which, after it has been thus changed, enters the stomach, where it is quickly dissolved and taken up by the blood. If you will hold a little arrowroot, which is almost pure starch, in your mouth for a few moments, it will lose its starchy taste and become sweet. The saliva has acted upon the starch and changed it into sugar.

9. **The Gullet.**—After the food is properly chewed it passes down into the stomach through a narrow tube about nine inches in length, called the *food-pipe*, or gullet, which begins in the back part of the mouth. There is another pipe just in front of the gullet called the *windpipe*. This extends to the lungs, and through it we breathe.

10. **How Food is Swallowed.**—How does it happen that the food goes down the right tube? There is a little contrivance called the *epiglottis* at the top of the windpipe. When we are about to swallow, this shuts down like a trap-door, and makes a bridge over which the food passes down the gullet into the stomach. When the food has passed over, the epiglottis opens again for us to breathe. Sometimes it happens that it does not close quickly enough, and a little bit of food goes down the "wrong

way," as we say. Violent coughing usually will bring it up again. If the substance is hard, like a coin or button, children sometimes choke to death. Taking choking children by the heels and shaking them will sometimes bring out the substance again.

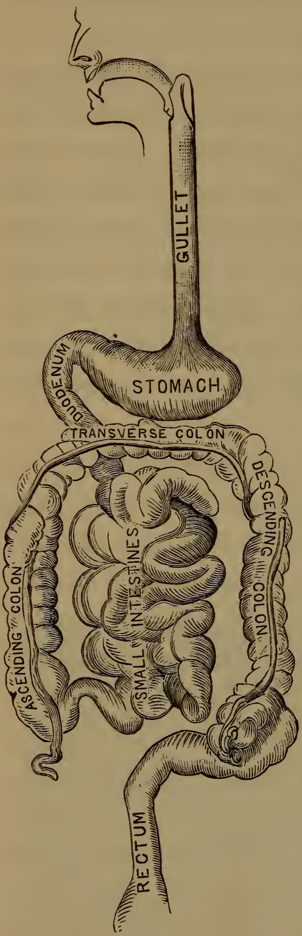

FIG. 23.—ALIMENTARY CANAL—including Gullet, Stomach, Large and Small Intestines.

11. THE STOMACH.—The stomach is a hollow pear-shaped bag (Fig. 22), holding from three pints to two quarts. It has two openings: the one through which the food enters and where the gullet ends is called the *cardiac*, or *heart orifice*, because it is near the heart; the other, through which the food goes out and into the intestines, is called the *pylorus*, or "gate-keeper." The pylorus guards the entrance into the intestines, and permits only such articles of food to pass out as have been properly acted upon in the stomach. Things, like coins or buttons, that are not food, are allowed to pass, because they can be of no use if retained.

12. THE GASTRIC JUICE.—As soon as the food gets into

the stomach, an acid fluid, clear and without color, flows out, drop by drop, from millions of little tubes in its walls. This fluid is called the *gastric juice*, and contains a substance called *pepsin*, which helps us to digest our food. The quantity of gastric juice used for this purpose, at each meal, is not less than three or four pints.

13. Action of the Gastric Juice.—There is also a constant churning motion caused by the contraction of the muscles of the stomach, which mixes the food thoroughly with the gastric juice. This juice acts on the albumens, which are contained in meat, eggs, and in general all animal substances, but has very little effect on starchy food. That part of the food which is digested in the stomach is at once taken up by the blood-vessels in the walls of the stomach, and the undigested part, called *chyme*, passes out into the intestines. The chyme contains all the fat, and also some of the starchy matters that have to be further digested in the intestines.

14. Action of the Stomach.—If we could see all this wonderful action which is going on in the stomach, how interesting it would be to watch it! On account of an accident which happened, some years ago, to a Canadian named Alexis St. Martin, doctors have been able to see this process. The man had been shot in the side and an opening, which never closed, was made in his stomach. The opening was about an inch in diameter, and through it the doctors could see how digestion went on, how long a time was required to digest his food, and what things were digested soonest. When he ate things that were not good for him, the inside of his stomach looked un-

usually red, and could not do its work well. It was also found that about two hours after an ordinary meal his stomach was empty. You may be sure this man was a great curiosity to the doctors, as well as to other persons who saw him.

15. The Intestines.—The intestines are a continuation of the stomach and consist of a fleshy tube about twenty-five feet long (Fig. 24). The first twenty feet of this tube, called the *small intestines*, is about an inch and a half in diameter; the other five feet, called the *large intestine*, is a continuation of the same tube, though larger round. To get all this into the small space it occupies in the abdomen, it is folded together a good many times, as we see in the figure.

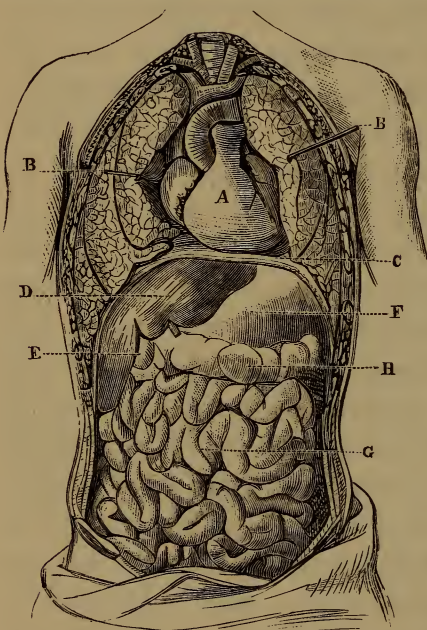

Fig. 24.—Section of Chest and Abdomen.

A, Heart.
B, The Lungs.
C, Diaphragm.
D, The Liver.
E, Gall-bladder.
F, Stomach.
G, Small Intestines.
H, Large Intestine.

16. Food in the Intestines.—As soon as the food enters the intestines it excites the flow of a new digestive fluid which enters through a small tube below the stomach. This fluid is formed by the union of two fluids, the *bile* and the *pancreatic juice.*

The bile is secreted by the *liver*, which is on the right side, in the upper part of the abdomen (Fig. 24), and is stored in the gall-bladder, a little bag attached to the under side of the liver. Its color is a greenish yellow, and it has a very bitter taste.

17. Bile and Pancreatic Juice.—The chief use of bile is to digest the fatty parts of the food upon which the gastric juice does not act. If you will ask the cook, she will show you the liver of a chicken with the gall-bladder attached; she is careful not to break the gall, as it will give the meat a bitter taste. The pancreatic juice comes from the *pancreas*, a gland situated behind the stomach (Fig. 25). You may already know it by the name of "sweetbread," as the butchers call it. By means of the bile, the pancreatic juice, and a fluid formed in the intestines, called the *intestinal juice*, the undissolved parts of the food we have eaten are

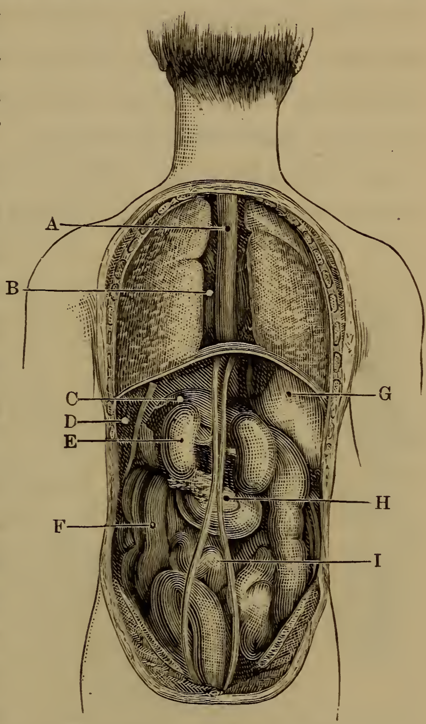

Fig. 25.—Chest and Abdomen—Back View.
A, Food-pipe or Gullet. E, Kidneys.
B, Heart. F, Large Intestine.
C, Stomach. G, Liver.
D, The Spleen. H, Pancreas.
I, Small Intestines.

changed in the intestines into a milky-white fluid called *chyle*, and are thus made ready to be taken into the blood.

18. How the Blood Takes Up Chyle.—This is done in two ways: by the blood-vessels, and by the *lacteals* (Fig. 25). The blood-vessels of the stomach absorb a good deal of the fluid; and the small intestines, also having blood-vessels, absorb more of it. The inside of the intestines is covered all over with millions of short thread-like bodies called *villi*, which give it the appearance and smoothness of velvet.

19. The Lacteals.—In each of these villi is a network of fine blood-vessels and a tube called a lacteal (Fig. 26), so called from its milky-white appearance. The lacteals dip down into the intestines and take up the fatty matters from the chyle. The lacteals all unite to form one tube called the *thoracic duct*, which passes upward through the chest, or thorax, and empties into a vein just below the left collar-bone. When this tube becomes obstructed, the food does little good, as is shown in those men who are exhibited about the

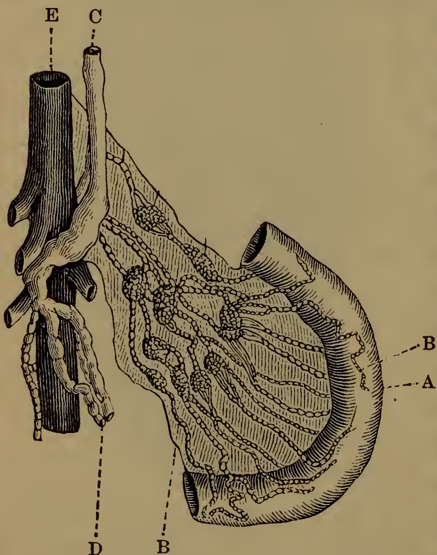

FIG. 26.—THE LACTEALS.
A, Small Intestines. B, Lacteals.
C, Thoracic Duct. D, Absorbents.
E, Blood-vessel.

country under the name of living skeletons. The indigestible part of the food passes into the large intestine, through which it is expelled from the body.

20. **What to Eat.**—We should eat those things that are nourishing and that, at the same time, can easily be digested. Fresh food, except the flesh of animals just killed, and new or hot bread, is more rapidly digested than that which is stale. Vegetable food is less stimulating than animal food, and on that account is better for children. Beef and mutton are more easily digested than veal and pork. Rich pastry, cake, candy, nuts, and raisins, if eaten at all, should be taken at our regular meals and in small quantities. Children are very apt to eat such things between meals, and when lunch or dinner time comes, they have no appetite and no relish for plain, well-cooked food.

21. **The Best Diet.**—The simplest diet is always the best. Bread and milk, or oatmeal and milk, eggs, and ripe fruits are easily digested. Some persons are made sick by eating things that to others are harmless. Some, it is said, cannot come near a table on which there is any cheese; to others lobsters are almost poisonous, and strawberries to many are more indigestible than any other fruit. Children should not be compelled to eat food that they dislike. A child with a good, healthy appetite will be likely to select food that is good for him.

22. **How Much Should We Eat?**—The quantity of food we require depends upon the age and occupation of the person and the amount of exercise taken. Every movement causes a waste of the tissues of the body. The

greater the amount of exercise, the greater the waste and the more food is needed to repair the waste. Those who lead active lives in the open air, as farmers and other laboring-men, need more food than those who work in-doors, and either stand or sit while their hands or brains are employed. Children who are growing rapidly need food, not only to make up for the natural waste, but to furnish material for the rapid growth of bones and muscles.

23. **Effects of Eating Too Much.**—We should be careful not to eat too much. It is better to stop eating before we are fully satisfied than to overload the stomach. If we get into the habit of eating too much or too rich food, we shall suffer from indigestion. The skin will become dark and muddy, instead of being a clear red and white, as it should be if our digestion is good. There will be ugly pimples on the face, and the breath will be offensive. Old persons do not need so much food as the young, nor do they relish their food so much.

24. **When to Eat.**—Three meals a day, from four to six hours apart, should be eaten. We should not eat between meals. The stomach needs rest as much as the other organs of the body; and if it does not get it, digestion will not be well performed. If we are very tired, it is better to rest before eating. Avoid severe exercise immediately after a full meal, as it is likely to stop digestion. Men who are accustomed to drive horses or to work them hard understand this. The horses must be given a little food, or must be driven slowly until their

food is digested. It is better not to eat just before going to bed. When we are asleep digestion goes on slowly. Children often injure their health by eating too hastily or by eating very little breakfast, because they are afraid of being late for school. Of course they are hungry before noon-time, and cake, candy, or pickles are bought to satisfy the craving for food.

25. **How to Eat.**—We should eat slowly and chew our food thoroughly. As a nation, we do not take time enough to eat. Children eat quickly because they want to play; men and women, because business or pleasure hurries them. If the food is well chewed, the saliva and gastric juice will act more readily. It is not well to drink too much when eating. Ice-water is not good for digestion. Even a wine-glassful cools the stomach so much that half an hour is needed after drinking it for the stomach to recover its natural warmth. Mustard, pepper, highly spiced sauces, and pickles are likely to injure the digestive organs if used frequently.

26. **Gum-chewing.**—Young people often indulge themselves in chewing gum. They chew it almost as constantly as men chew tobacco. This habit is injurious to the glands connected with digestion. It increases the flow of the saliva, which ought to be used only in dissolving our food. It also excites all the glands connected with the nourishment of the body, without providing food for them to digest. Thus, you see that it is not only a disagreeable but a hurtful habit.

27. **Effect of Alcohol on Digestion.** — Alcoholic drinks taken into the stomach irritate it and hinder di-

gestion. Taken in large quantities they may almost stop digestion, and cause a painful form of dyspepsia, destroying all appetite for food. You will find that drunkards eat very little, but are always thirsty. This is because they have taken alcohol, which absorbs the water from the body and creates a thirst for more. The liver is more likely than most of the other organs to become diseased by the use of alcohol. It becomes inflamed and enlarged at first, and afterwards decreases in size, becomes hard and roughened, and is then called the *hob-nailed liver*, or the drunkard's liver. In some countries geese are fed with food soaked in alcohol to make the large livers for "goose-liver" pies which by many are thought to be a great delicacy. The effect of alcohol on the kidneys is very much like its effect upon the liver. The kidneys become diseased so that they cannot remove impurities from the blood, and as a consequence the whole system is poisoned.

QUESTIONS.

1. What is digestion? 53
2. Where is the food digested? 53
3. Should we chew our food well? Why? . . . 53
4. What is the saliva? Where does it come from? . 56
5. What are its uses? 57
6. After the food is chewed, where does it go? . . 57
7. What two pipes or tubes are near together? . . . 57
8. What contrivance sends the food down the right tube? . 57
9. Explain how it is done. 57
10. What is the gullet? Tell all you know about it? . 57
11. What would happen if this little trap-door did not do its duty? 58
12. What must be done if coins or buttons get into the windpipe? 58
13. Describe the stomach and its uses 58

14. How many openings has it? What are they? . . 58
15. Of what use is the pylorus? 58
16. Is it treating the stomach well not to chew the food properly? Why not? 58
17. What is the gastric juice? Where does it come from? . 59
18. How much is used each meal for digestion? . . 59
19. What causes the churning motion? Of what use is the motion? 59
20. What becomes of the food that is not digested in the stomach? 59
21. Has any one ever seen this process? 59
22. Tell the story of Alexis St. Martin. . . . 59
23. What are the intestines? 60
24. What is the size of the small intestine? Of the large? . 60
25. Where are they situated? 60
26. What two fluids is the food mixed with in the intestines? 60
27. Where is the liver situated? 61
28. Where is the bile stored? What is its color and taste? . 61
29. How is the food changed to chyle? 61
30. What is the office of the blood-vessels of the stomach? . 62
31. Of the blood-vessels of the small intestines? . . . 62
32. What are the villi? What tubes do they contain? . 62
33. What is the duty of these tubes? 62
34. With what tube do they unite? 62
35. Where does this tube empty? 62
36. What things are most easily digested? . . . 63
37. Does animal or vegetable food digest more rapidly? . 63
38. Why is ice water not good for digestion? . . 63
39. Is it best to eat a variety of food at each meal? . . 63
40. Is there any rule as to the amount of food we should eat? 63
41. Upon what does the amount depend? . . . 63
42. Why do children need more food than adults? . . 64
43. Should we eat between meals? Why not? . . . 64
44. Should we eat much candy, cake, or other sweets? . 64
45. What kind of food is best? 64
46. What is a safe rule for eating? 64
47. What effect will indigestion have on the complexion? . 64
48. Do the old need as much food as the young? . . 64
49. How often should we eat? 65
50. Why should we not eat between meals or when tired? . 65
51. Why should we not eat before going to bed? . . 65
52. What can you tell about the habit of chewing gum? . 65

CHAPTER VII.

THE BLOOD, AND ITS CIRCULATION.

1. **THE BLOOD.**—When we cut ourselves, or prick our fingers with a pin, and wound the true skin, the blood comes. If the injury is deep and wide, the blood runs very fast, and we cannot always stop it. A little boy to whom this was told, said, "Yes, I can; I can always stop it, for it gets hard on the outside." That hardness is the thing that stops the blood from running, as you will see presently; but even that little boy would find that the blood might flow so fast that it had no time to harden. He could not stop the bleeding unless he knew exactly how to do it.

2. **THE CORPUSCLES.**—The blood, as it first flows out, looks red; but if we put a drop of it under a microscope (which is a glass that will make things look many times larger than they usually appear), we shall see that it is a clear fluid, in which a great many little bodies called *cor-pus-cles* float. These little bodies give it a red color (Fig. 27). We can understand this, if we take a glass partly full of water and then drop into the glass as many red beads as

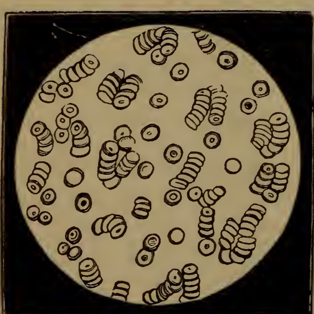

FIG. 27. THE BLOOD-CORPUSCLES, HIGHLY MAGNIFIED.

it will hold without having the water overflow. If we stand a little way off, the water will look red, because the beads give it that color.

3. **Color of the Blood.**—If you should fill the water of a brook with little red fishes, very small, as small and crowded together as closely as grains of sand, the water would look red, would it not? Now you know why these little bodies make the blood look red. They are so small that we can hardly get any idea of their size. In a single drop of blood that might hang on the point of a needle there are a million of these little bodies. Beside the red corpuscles, you will see others that are white. They are a little larger than the red ones.

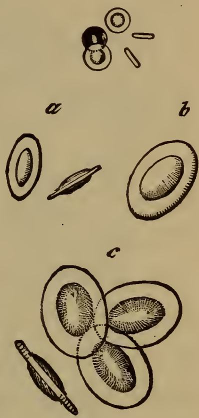

Fig. 28.

a, Oval Corpuscles of a fowl. *b*, Corpuscles of a frog. *c*, Those of a shark. The five small ones at the upper part of the figure represent the human corpuscles magnified four hundred times.

4. **Use of the Corpuscles.**—"What use are these little bodies in the blood?" They have the power of taking up gases. We breathe oxygen into our lungs, and breathe carbonic-acid gas (a kind of dead air) out of them. These little bodies take up the oxygen we inhale, and carry it all over the body; but the carbonic-acid gas, that would hurt us if it should remain long in the body, they take to the lungs, which expel it. We shall learn more about this in the next chapter which tells why and how we breathe.

5. **Coagulation, or Clot.**—If we put blood that has just been taken from the body into a dish, and let it

stand a few hours, it is separated into two parts. The *clot*, which is thick like jelly, sinks to the bottom; the other part, a clear straw-colored fluid called *serum*, covers the clot. It is this thickening, or *coagulation*, of the blood that often saves us from bleeding to death, because it stops the mouths of the blood-vessels that have been cut or hurt, so that no more blood can come from them. When you cut yourselves, your parents or the doctor ties up the wound, so that the blood may thicken and thus stop running. This *coagulation* is what the little boy referred to when he said it "got hard on the outside."

6. **Discovery of the Circulation of the Blood.**—The blood is never still while we are alive. It starts from the heart, and by a great number of tubes, large and small, is carried all over the body. How this is done we shall see presently. The circulation of the blood has been understood only since 1619. The man who discovered it was an Englishman, whose name was William Harvey. He was a physician to the King of England. He was persecuted and derided at first, but he lived nearly forty years after the discovery, long enough to see it accepted by every one, and to know that he was honored as a benefactor of mankind. Before Harvey's time the belief was that *air* instead of blood circulated in the arteries of which we shall learn.

7. **The Heart.**—The heart is the wonderful engine by which the circulation of the blood is carried on. It is in the middle of the chest, between the two lungs, and is placed a little to the left side, where we can easily feel it beat. It is not much larger than a man's fist. By its

constant beating, which is as regular as the ticking of a clock, the blood is kept in motion. It never tires, and stops beating only when we die. (Fig. 29.)

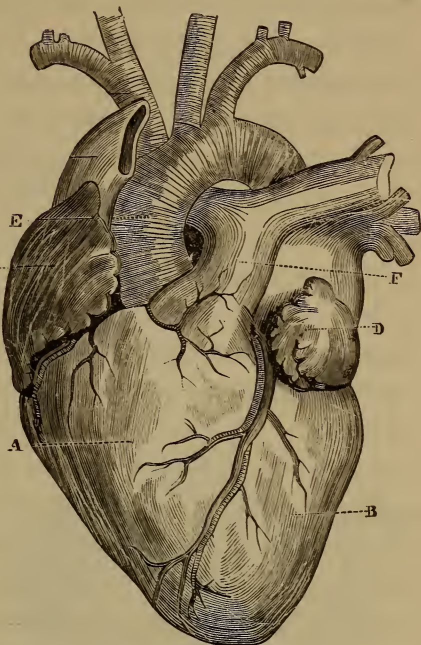

Fig. 29.—The Heart and Large Vessels.
A, Right Ventricle. D, Left Auricle.
B, Left Ventricle. E, Aorta.
C, Right Auricle. F, Pulmonary Artery.

8. Chambers of the Heart.—The heart contains four chambers. It is first divided down the middle, from the top to the bottom, so that no blood can pass from one side of the heart to the other. Each of these halves is then divided across, so that there are two lower and two upper chambers. The upper ones are called the right and left auricles, the lower ones the right and left ventricles. Each chamber has a little *valve*, or trap-door, which opens to let the blood through, and closes to prevent its return. All these actions of the heart, which are contractions and expansions, are done without our thinking about them. If each heart-beat depended upon our remembering it, we should never be able to attend to anything else, and should die if we should go to sleep.

9. **The Arteries.**—The tubes by which the blood is carried from the heart to all parts of the body are called *arteries*. The arteries spring from the heart by a single hollow tube, which, like the trunk of a tree, throws off many branches. These *branches* are divided again and again, and constantly become smaller and smaller, until the finest of them are so very minute that we cannot see them without a microscope.

10. **The Veins.**—The tubes by which the blood returns to the heart are the *veins*. At first they are not larger than the smallest artery of which we have spoken, but, uniting together as they advance, they grow larger, reminding us of the way in which the tiny rootlets of a plant unite to form the root, or the little streams flow together in order to form the mighty river. The large veins commonly lie side by side with the arteries serving the same part of the body, but the currents within the veins and arteries flow in opposite directions.

11. **The Capillaries.**—There are also other tiny tubes, a great deal finer than the finest hair, which connect the veins and arteries, forming a net-work between them. These are called *capillaries* on account of their being so small and hair-like. *Capilla* means a hair. The capillaries carry the blood from the arteries into the small veins, these veins carry it into two of the largest veins of the body that empty into the right auricle of the heart. The arterial blood in the capillaries furnishes food to all parts of the body.

12. **Use of Capillaries.**—The different organs of the body being constantly used, need to be repaired, just as

our shoes and our clothes need repairs when worn with use. So these tiny little tubes, that run through each organ, select from the blood what is needed to repair that organ. Fat, muscles, bone, and the heart itself are all fed by means of these little tubes. Through the capillaries also the impure blood is carried to the veins, and by them is taken back to the heart to be purified. This is best done during sleep, as the body is then quiet and the circulation is slower and more regular than when we are awake.

13. The Circulation of the Blood. — The circulation of the blood is a very curious and interesting thing. Let us see if we can understand it. When the blood has passed through all the arteries of the body, and whatever is needed to nourish the different organs has been taken out of it, its color changes from a bright red to a dark blue. It is now impure, and, as it cannot nourish the body, it must be purified. How is this done?

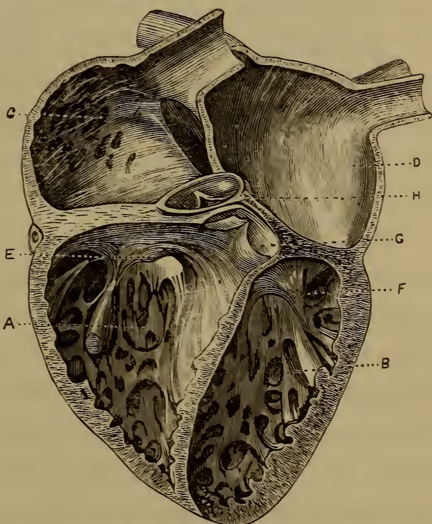

Fig. 30.—Section of the Heart.

A, Right Ventricle. B, Left Ventricle. C, Right Auricle. D, Left Auricle. E, F. Inlets to the Ventricles. G. Pulmonary Artery. H, Aorta.

14. The Blood in the Heart.—The blood is carried by the veins into the

upper chamber of the right side of the heart, which, you have been told, is the right auricle. This chamber contracts, and sends the blood down through the little trap-door into the right ventricle (Fig. 30). This ventricle contracts and sends the blood along the great artery through the lungs, where it is made pure and red again by the oxygen it gets there, and by the impure gases it throws out. When this is done, the blood is sent out from the lungs into the left auricle, from which, through another little trap-door, it passes into the left ventricle. This contracts and hurries the blood through the large and small arteries to the ends of the fingers and toes. The little capillaries then take it into the small veins, which carry it into the larger ones, by which it is taken back into the heart, to begin again the same journey. Look carefully at the pictures you have before you and study them well, so that you can understand and trace the circulation of the blood through your body.

15. **Appearance of the Blood.**—If your teacher or any of your friends have a microscope, you will be very much interested in looking through it at the circulation of the blood in the web, or thin part, of a frog's foot (Figs. 31, 32). Under the microscope you will see very plainly one set of vessels, the arteries, with the blood rushing through them from the heart, as the water rushes along a rapidly running river; then another set, the veins, with the blood flowing slowly in the opposite direction, as the water creeps along the bed of a sluggish stream; and between the arteries and the veins you can see the capillaries, which form a net-work with walls so fine that you can

see through them. Through these capillaries the tiny corpuscles can pass only in "single file."

16. The Blood in the Capillaries.—The motion of the blood in the capillaries is very curious. It hurries along in one direction, then stops, and turns in the opposite direction, and sometimes these little tubes are nearly empty. How long do you think it takes all the blood in the body to go from the heart, through the lungs, back to the heart, and from that through the whole body, to the ends of the

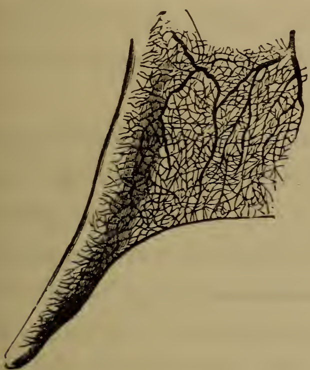

Fig. 31.—Web of a Frog's Foot, slightly magnified.

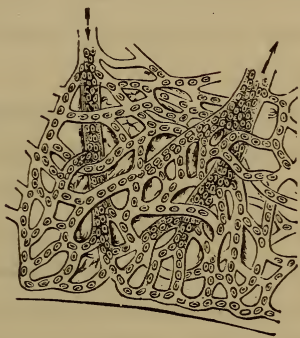

Fig. 32.—Margin of Frog's Web, magnified 30 diameters.

fingers and toes, until it gets back to the heart again? It takes about two minutes to make the complete round. This it does without stopping, day after day, through your entire life, and does it also without your thinking or troubling yourselves about it. Is not this a wonderful thing? And are not these bodies of ours, that are so curious and so wonderfully made, worth studying about, so that you may learn to take care of them, and not abuse

and neglect them, as many children do for want of knowledge?

17. The Work of the Blood.—We can compare the arteries, and what they do for our bodies, to the water supply of a great city. The heart is like the pumping-station at the reservoir; and the arteries, which carry the pure blood out of it to supply our bodies, are like the large pipes which carry water down from the reservoir. The small arteries are like the smaller water-pipes, which go into all our houses in order that each house may have all the water it needs. So the smaller arteries carry the blood to all parts of our bodies, that each part may be supplied.

18. Impure Blood.—When the water has been used for washing, cooking and other things, and is no longer fit for use, another set of pipes, the drain pipes, carry this impure water from each house through the sewer pipes to the river, where it mingles with the water there. The foul matter sinks to the bottom, and the pure water rises in the form of mist or vapor into the clouds, to fall again in the form of rain or snow upon the earth, and is again carried into the reservoir to be used. The veins do the same thing for the impure blood of the body. When all that is wanted for use is taken from the blood, and it needs to be purified, the little capillaries carry it to the veins; the veins, like the sewer pipes, take this impure blood back to the heart, and it is sent to the lungs to be purified and made ready for use again.

19. How to Promote Good Circulation.—We should exercise regularly. When cold, a run or a brisk walk

will warm us, and will cause our blood to circulate well. A bath in the morning, followed by a hard rubbing with a coarse towel, is also good. Avoid violent and long continued exercise. It will do more harm than good. Tight clothing is injurious. It presses upon the blood vessels that are near the surface of our bodies, thus preventing a free circulation of the blood. Tight collars, tight belts, and tight shoes will also injure us, for the same reason. Our clothes should be warm, light, and not too tight. Tight clothes and tight lacing cause headaches, cold hands and feet, and many other aches and pains which we could prevent if we knew what produced them.

20. The Pulse.—If we should attach a hose-pipe to the mouth of a common pump, we would notice every time we pressed down on the handle of the pump that the water came out of the pipe in a jerky manner. If the pipe be rubber, and we press it, we can feel a throbbing of the water passing through. In the same way, every time our heart beats, there is a wave-like motion sent through the arteries, and this motion is called the *pulse*. The arteries sometimes come near the surface, as in the wrist. By putting the finger upon the wrist we can count the beats or pulsations. In this way, as well as some others, a doctor tells whether we are sick or well, and whether our blood goes through the arteries too quickly or too slowly for perfect health. How can he do this? Because he knows how often in a minute the pulse of a healthy person ought to beat. If he finds that your pulse-beats are not right, he tries to find the cause. The

pulse can be felt wherever an artery comes near the surface of the body. When a person is very weak his pulse can hardly be felt. In fevers it is often rapid and irregular.

21. **Effect of Alcohol upon the Heart.**—Soon after a person has taken alcohol into his stomach, his face gets red, he feels warm within and the heart beats more rapidly than usual. We say that the alcohol acts as a stimulant upon him. It affects his heart, as a whip or spur affects a horse. It causes the heart extra work, to expel the alcohol from the system; so there is a loss, not a gain, of strength. The alcohol has weakened the nerves which control the flow of blood in the blood-vessels, and the heart must work harder to fill them.

22. **Does Alcohol make us Fat.**—Alcohol is said to make persons fat. The fact is that they become so sleepy and inactive from drinking, that as a result they become fleshy. Alcohol in itself has really no fattening power. Alcohol sometimes produces fat in the muscles of the body, which makes a person weak instead of strong. The blood also undergoes a fatty change, which prevents it from nourishing the body.

QUESTIONS.

1. What happens when we cut our fingers? 68
2. Can you always stop the flow of blood? Why not? . . 68
3. What is the color of good blood? 68
4. Why does it look red? Give examples. . . . 69
5. How many corpuscles are there in a drop of blood that might hang from the point of a fine needle? . 69
6. Are there any beside the red corpuscles? . . . 69
7. What use are they? What are their uses? . . 69
8. What do we breathe into our lungs? What out? . . 69
9. If you let blood stand in a dish for some time how will it look? 69
10. What are the two parts called? 70
11. What is coagulation? 70
12. How does it prevent us from bleeding to death? . . 70
13. Is the blood in a living person ever still? . . 70
14. How long has the circulation of the blood been understood? 70
15. Who discovered it? Tell something about him? . . 70
16. What is the use of the heart? Where is it situated? . 70
17. How large is it? What use is its beating? . . . 70
18. How many chambers does the heart contain? . . 71
19. Describe the divisions? 71
20. What are the upper ones called? 71
21. What are the lower ones called? 71
22. What is the use of the valve in each chamber? . . 71
23. Do we think about these actions of the heart? . . 71
24. What are the arteries? 72
25. From what do they spring? 72
26. Tell about the branches of the tubes? 72
27. What are the veins? 72
28. From what do they start? 72
29. What can you tell me about their size? . . . 72
30. What are the capillaries? 72
31. What work do they do? 72
32. How do they furnish food for the body? 73
33. What is the best time for repair of the body? . . 73
34. When the blood has passed through the arteries and the nourishment has been taken from it, where does it go? 73
35. From the right auricle where is it sent? 74

CHAPTER VIII.

Respiration or Breathing.

1. When a person stops breathing we say that he is dead. The air we breathe into our lungs is necessary to keep us alive. It purifies the blood, as we learned in the last chapter, and by our constantly breathing it, our bodies are supplied with a very necessary nourishment. Not only men but all the lower animals must breathe in order to live. When the horse, cow, and dog breathe we can see their sides rise and fall; and when they have been running rapidly in cold weather we can see the moisture in the breath as it comes out of their nostrils. They pant as we do when we run too fast.

2. **The Breath.**—Have you not noticed on cold winter mornings how your own breath looks like steam, as it comes from your mouth, and have you not held up your fingers, when they were stinging with cold, to warm them by breathing upon them? The air as we draw it through our teeth into our mouths feels cold, but it is warmed by its passage through the lungs. That is the reason it feels warm to your fingers, as it comes from your mouth. Plants breathe through tiny little holes that are in the leaves, but in a different way from animals. You will learn all about that when you come to study Botany.

3. The Lungs.—(Fig. 33.) The lungs are the organs with which we breathe. There are two of them, one on each side of the chest; which they almost fill. The substance of the lungs is soft, elastic, and very much like a sponge, and when thrown into the water it will

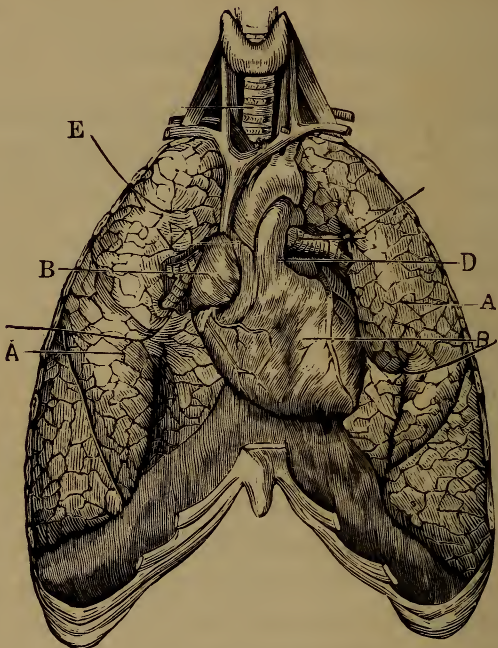

Fig. 33.—Organs of the Chest.

A, Lungs. D, Pulmonary Artery.
B, Heart. E, Trachea.

float. If we press upon it with the fingers it sinks down, but will rise again like a sponge when we take the fingers off. We also notice a crackling sound when pressure is made upon it. This is caused by the air with which it is filled being forced out.

4. **The Tubes for the Passage of the Air.**—The longest of these tubes is the windpipe, or *trachea*, which runs along the front of the neck. It is upon the windpipe that a man presses when he wishes to choke another person to death. Probably you have often pressed your fingers upon your windpipe and felt as if you were

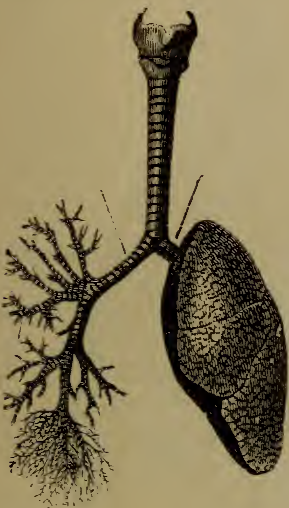

Fig. 34.—Larynx, Trachea, and Bronchial Tubes.

Fig. 35.—Diagram and Section of the Air-cells.

choking. If this pressure should be long continued, no air could get into the lungs, and we should die. At the top of the windpipe is the *larynx*, a box of cartilage containing the vocal cords. The front of it is very prominent in thin persons and it is then spoken of as "Adam's Apple."

5. **Bronchial Tubes.**—The lower end of the windpipe is divided into two parts or branches, one going into

each lung (Fig. 36). These large branches are again divided, something like the arteries, into many little branches or bronchial tubes, as they are called, which get smaller as they go down, until they are as small as the finest hair. On the ends of each of these little tubes is a cluster of little pouches or "air-cells" (Fig. 35), having very thin walls, and the whole is covered with a very

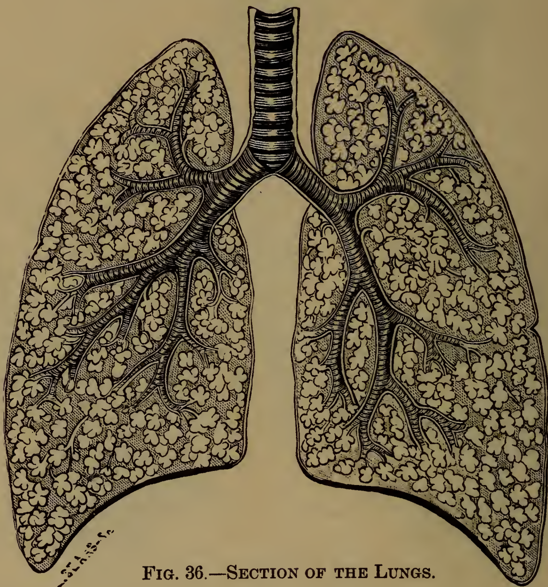

FIG. 36.—SECTION OF THE LUNGS.

firm net-work of capillaries, of which we learned in the last chapter. When we take in a breath, these cavities are filled with air and the chest swells out; but when the air is forced out, the chest falls again.

6. **VOCAL CORDS**—(Fig. 37). At the top of the windpipe, or trachea, is the *larynx*. This, as we have been told, is a box of cartilage, in which are the organs of voice, or

vocal cords. These cords are stretched across the box; as the air passes to and from the lungs, they are set in motion. This produces the sounds we call the *voice.*

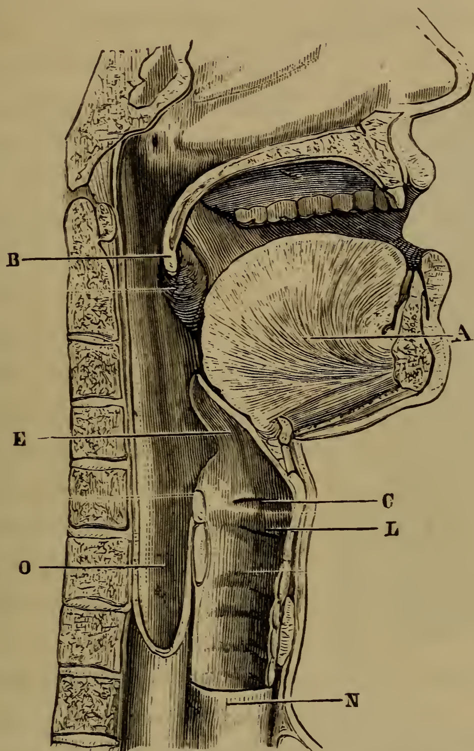

FIG. 37.—SECTION OF THE MOUTH AND THROAT.

A, The Tongue. E, Epiglottis. N, Trachea.
C, Vocal Cord. L, Larynx. O, Œsophagus.

7. **EPIGLOTTIS.**—At the top of the windpipe, which opens at the back of the mouth, is the cover or trap-door we have before spoken of. It is called the *epiglottis.* This opens to let the air pass in and out, and closes when

we swallow our food. Sometimes it fails to shut down over the opening, and the food goes down the windpipe, instead of the food-pipe, causing us to choke until we cough it up again.

8. **How We Breathe.** — There are two motions in breathing,—*inspiration*, or drawing the air into the lungs, and *expiration*, or forcing it out again. We have learned that the lungs are elastic, or easily stretched. When the air passes into the lungs and fills the air-tubes, the elastic tissue of the lungs swells, and the chest fills out or expands, as a rubber ball swells out when we "blow it up." This is inspiration. When the air is forced out again through the same tubes the chest sinks down. This we call expiration. This up and down motion is repeated with each breath we draw. The motion upwards is seen in the lifting of the ribs; the motion downwards is not so apparent, as it is caused by a muscle called the *diaphragm*.

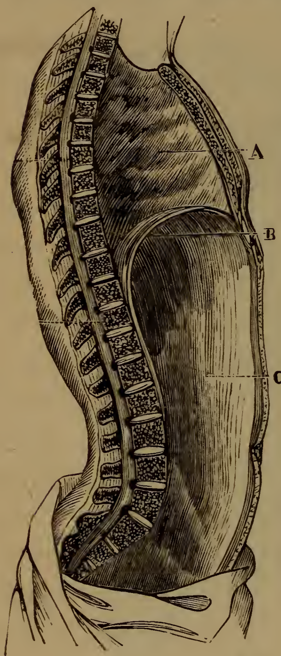

Fig. 38.—Section of the Trunk. A, Chest. B, Diaphragm. C, Abdomen.

9. **The Diaphragm.**—This muscle is a thin partition, which separates the chest from the abdomen (Fig. 38). In its natural position it rises up into the chest like a dome. When we breathe the air into the lungs, it con-

tracts until it is flat. As soon as the air is driven out of the lungs the diaphragm rises into its dome-like position again. These movements go on, without our thinking about them, as long as we live.

10. How Often We Breathe.—We breathe about once during every four beats of the heart, or about eighteen times a minute. When we walk fast, or when we run, the action of the heart is increased, and a larger amount of blood is sent to the lungs, so that they have to act more rapidly. If they cannot keep up with the action of the heart, we are in distress for want of air—"out of breath," as we say. Although we are not obliged to think in order to breathe, we can, if we "will" to do so, stop breathing from fifteen to twenty seconds. If we expel all the impure air from our lungs by taking several very long breaths, we may even remain for one and a half or two minutes without breathing. It would be well to remember this. Then, if we are ever compelled to pass through a burning building, we may shut the mouth and not breathe until we have passed beyond the flames and smoke.

11. Composition of Air.—The air we breathe is composed of two gases, oxygen and nitrogen. Oxygen is powerful and active; too active for us to breathe, unless it is mixed with something else. Nitrogen is weak, and cannot alone support life. These gases are so mixed that there is four times as much nitrogen as oxygen. That is to say, one fifth of common air is oxygen.

12. Changes in the Air Made by Breathing.—Animals confined in a close box or chest, where they cannot

get fresh air, will soon die. A lighted candle placed in it will soon be put out. Why is this? Because there is not enough oxygen in the air that has been breathed once to sustain life. Neither is there enough to keep up a flame. Air that has been once breathed is not fit to breathe again. The air is changed while in our lungs. The oxygen is kept by the blood, and another gas, called carbonic-acid gas, that is hurtful to our bodies, is thrown out.

13. **Need of Fresh Air.**—You have perhaps heard the story of the "Black Hole of Calcutta," a small room with only two little windows in it, into which a hundred and forty-six Englishmen were crowded one hot night by a cruel man in India, who had taken them prisoners. They struggled and fought with one another to get near the windows for fresh air. In the morning only twenty-three of the poor men were alive. If a room, like a schoolroom or a public building, is filled with people and the air that has been breathed is not allowed to get out and fresh air to get in, we shall find that people will become faint and dizzy and complain of headaches; and yet they do not know why they feel so. Poor persons in their small, close rooms in the cities suffer from breathing this impure air; and the children are often pale and sickly, when a little fresh air and sunshine would make them well again.

14. **Causes of Impure Air.**—Stoves and furnaces used for heating rooms often cause death by the carbonic-acid gas they send out. Where such heaters are used, the rooms should have plenty of fresh air. We have some-

times noticed what a close, disagreeable odor there is when we enter a room in which there are a great many persons. It is because fresh air is shut out. The unpleasant odor is caused partly by the animal matter contained in the moisture that is breathed out of our lungs as well as what is thrown off by perspiration. Air that is pure has no odor. When sick, we throw off with our breath and from our body impurities that often cause those who are near us to take the disease, or, as we say, to "catch it." For instance, scarlet-fever, small-pox, measles, and other diseases which we call contagious are given by a person who has them to those who come very near him. The better a sick-room is ventilated, the less liable are those about the patient to take the disease.

There are many things particularly in and about cities that tend to make the air impure. Bone-boiling factories, chemical-works, kerosene-works, soap-factories, slaughter-houses, and other things of the kind are very injurious to health, besides causing unpleasant odors, which make it disagreeable for people living near them.

15. **Moisture in the Breath.**—On a very cold morning, when we are walking fast or running, we notice a vapor, like steam, coming from our mouths. A lady's veil or a man's moustache will often be covered with this vapor, frozen and looking like little particles of ice. The window-panes in our rooms, in very cold weather, are sometimes covered with the pretty frost-work that children admire. We notice it more when a room has been tightly closed during the night. This appearance is

caused by the air that is breathed from our lungs. It shows that the air we send out from our lungs contains water, which was not in the air we breathed into them. In hot weather we cannot notice this moisture unless we breathe upon a looking-glass or some other polished surface. Then we shall see that the thing we have breathed upon is dim, and feels wet to the touch.

16. **Carbon and Oxygen.**—If we are all the while breathing out carbonic-acid gas, and all the people in all the cities and large towns as well as in the country are doing the same, how does it happen that there is any pure air left for us to breathe? Remember also that not only men, women, and children, but all the lower animals, even little birds, fishes, and worms need the oxygen of the air. Our fires and lights consume much more. Why has not all the oxygen been used up long ago? Where does the needed supply come from? and what becomes of the carbonic-acid gas? Carbon and oxygen are both useful as food for our bodies. Breathed in the form of carbonic-acid gas, they are injurious, causing convulsions and even death. Sugar in its pure state is good and salt is also good if used as they are needed in our food. But if we mix them together, and then put the mixture into our tea or coffee, or into our soup, we could not drink the one nor eat the other. If we could separate them so that they could be as they were before they were mixed, they would again be useful.

17. **What Plants Breathe.**—This separation of the carbon from the oxygen is what the trees, grass, and plants are doing with the carbonic-acid gas. They take

up the carbon from the impure air and leave the oxygen. Carbonic-acid gas contains the true food for the vegetable world. The carbon is retained and used. It enters into fruits, grains, and eatable roots, while the oxygen is given back for the nourishment of the animal world.

18. **How the Air is Purified.**—But, we may ask, how does all the bad air get from the cities, where there are so few trees and plants to use it, into the country, where there is enough vegetation to purify it? We know how constantly the air is in motion: sometimes moved gently by breezes, and sometimes violently by storms. By this movement the impure air of our cities and the pure air of country and of ocean are made to mingle much more freely than they would if there were a constant calm. Then the rain in falling has the power to wash out some of the impurities of the atmosphere, which, in the form of carbonic-acid gas, become food for plants. This is the wonderful plan of our Creator for purifying the air and giving to everything He has made exactly what it needs.

19. **Ventilation.**—We have learned why the air of our sleeping-rooms, schoolrooms, and public buildings is often impure. Now let us inquire how we can keep the air pure in our rooms without danger of our taking cold. In the summer this is an easy matter, as the doors and windows are almost always open. When our windows are of the common sash kind (Fig. 38), a good supply of fresh air may be obtained without a draught by placing a board about four inches wide under the lower sash. The window is thus closed against rain and snow, but

allows a supply of fresh air to enter between the sashes. If we open the windows or doors at opposite sides of the room, the bad air will be carried off, and pure air will take its place. If we have but one window in the room, it is a good plan to open it at the *top* as well as at the *bottom*, a little way even in very cold weather. The bad air, so long as it is warm, is lighter than the pure air and rises to the top of the room. For this reason it will go out at the top of the window, while the pure air, being heavier, comes in at the bottom.

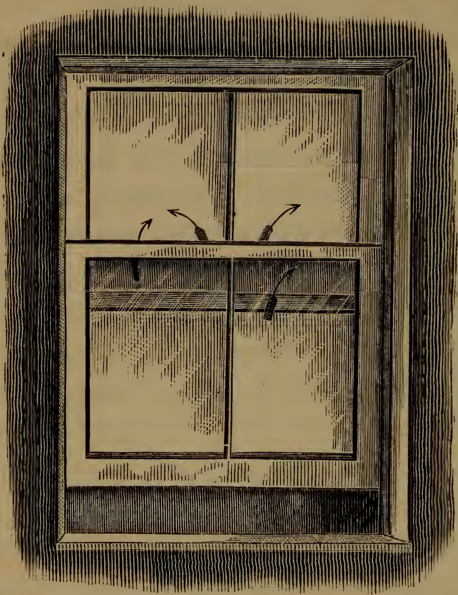

FIG. 38.—Showing manner of ventilating by inserting strip of wood beneath lower sash of window.

20. **BED-ROOM VENTILATION.**—We need not be afraid of too much fresh air in our sleeping-rooms. Even in cold weather we can have clothing enough on our beds to keep us warm; and cold air in our rooms, if it is fresh, is better than bad air. Night air, that so many people are afraid of, will not hurt us. We all know that we sleep better, when the air is pure at night, and awake feeling rested and ready for work again. On the other hand, if we

shut out the pure air, we awake feeling tired, and are pale and irritable. The habit of breathing tobacco-smoke through the nose injures the delicate membrane of the throat and lungs. Cigarette-smoke is particularly hurtful.

QUESTIONS.

1. What effect has the air upon the lungs? 81
2. What effect upon the blood? 81
3. Does anything breathe except persons? What? . . . 81
4. How does your breath look on a cold morning? . . . 81
5. You draw in cold air,—why is it warm when it comes from your mouth? 81
6. Do plants breathe? How? 81
7. What are the lungs? 82
8. How many are there and how situated? 82
9. Describe the substance of the lungs? 82
10. What is the wind-pipe? 83
11. If you press upon it, what is the effect? 83
12. What is the larynx? 83
13. Could any person be killed by pressing upon his wind-pipe? Why? 83
14. How is the wind-pipe divided in the chest? 83
15. Describe the bronchial tubes. 84
16. What are the air cells, and how are they covered? . . . 84
17. How is the chest affected when they are filled and when they are emptied? 84
18. Where is the larynx? Describe it. 84
19. What are the vocal chords? 84
20. Where is the epiglottis situated? 85
21. What is its use? 85
22. If it fails to shut, what happens? 86
23. What is inspiration? 86
24. What is expiration? 86
25. When the air passes into the lungs what effect does it have upon the air tubes and upon the chest? . . . 86
26. How is the chest effected when the air is forced out? . 86
27. By what is the upward motion caused? 86
28. By what is the downward motion caused? 86
29. What is the diaphragm? 86

CHAPTER IX.

The Nervous System.

1. We have been studying about *digestion*, *circulation*, *and respiration*, which are common to vegetables, the lower animals, and to man. These are called *vegetative functions*. As the body is nourished by the blood which circulates to all its parts, giving to each organ what it needs, so the trees and plants, by their roots, stems, and trunks, convey a fluid called *sap* through all their parts. This sap does for them what the blood does for our bodies. In other words, it causes their growth and nourishes them. Besides this, the leaves, which may be called the lungs of the plant, take from the air a gas which is hurtful to man, but which is the life of the plant. This process is called *vegetable respiration*.

2. **The Nerves.**—We, as well as the lower animals, have, in addition to these *vegetative functions*, another set of organs, by which we know and are able to take an active part in what is going on around us. These powers, among which are the sense of feeling, the powers of motion, and volition, or the ability to "will" to do anything, place the animal above the plant, and man above the lower animals, because he has these powers in a higher degree.

FIG. 39.—THE CEREBRO-SPINAL SYSTEM.

3. **The Nervous System.**—We find that all parts of the body are protected from injury by an unseen something that warns us of danger. When we come too near the fire, or when we are out in the cold too long, we feel pain. When a person raises his hand to strike us, we, "by instinct," as we say, dodge the blow. When we come in contact with many other things that would hurt us, this unseen agent warns us to avoid them. This agent which helps us to avoid danger and so carefully seeks to protect every part of our bodies is called the nervous system. The brain, spinal cord, and nerves are (Fig. 39) the principal parts of this system which serves the body as a complete telegraphic system, the brain being the principal office. We shall see by and by how this is done.

4. **The Brain.**—The brain is one of the most important and useful organs in our body. It fills the great cavity of the skull; is egg-shaped, and is divided into two parts,—the *cerebrum*, or large brain, and the *cerebellum*, or small brain (Figs. 41 and 42). It is a curious, whitish, pulpy-looking substance, marked all over in wavy-looking furrows, about an inch deep, looking something like a cloth that has been squeezed in the hand. It weighs about three pounds, or nearly fifty ounces in a grown person, although some brains weigh much more. The brains of Daniel Webster and Agassiz each weighed fifty-three and a half ounces. These are among the largest brains of which the weight is known. A large brain is thought to be the sign of a great mind; but the quality, as well as the size, must be considered. The brain of an idiot does not often weigh more than thirty ounces.

5. **The Cerebrum** (Fig. 40).—The cerebrum, or brain proper, fills up the top and front of the skull, and is very much larger than the cerebellum, or "little brain." A deep groove divides it lengthwise into two equal parts called *hemispheres.* The outside is marked all over with winding, irregular furrows, as has been said. It is gray in color, and contains nerve-cells, as well as a great many blood-vessels. This gray matter, which is about a fifth of an inch thick, goes down into all the furrows. On that account there is much more of it than if it covered only the top of the brain as a smooth surface. The interior of the brain is composed almost entirely of a white substance made up of nerve-fibers (Fig. 41).

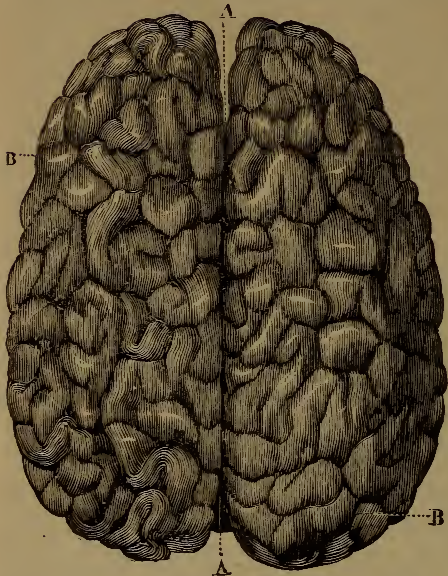

Fig. 40.—Upper Surface of the Cerebrum.
A, Longitudinal Fissure.
B, The Hemispheres.

6. **The Cerebellum.**—The little brain is divided, like the cerebrum, into two parts. The surface is composed of the gray matter, and the interior of the white matter. It is again divided by many ridges which are parallel, or side by side with each other, and which go down deeply into the white matter, looking somewhat like the trunk

FIG. 41.—VERTICAL SECTION OF THE BRAIN.
A, Left Hemisphere of Cerebrum. E, Upper Extremity of the Spinal Cord.

FIG. 42.—LOWER SURFACE OF THE BRAIN.
The numbers refer to the pairs of nerves.

FIG. 43.—MEDULLA OBLONGATA. A, Cerebrum; B, Cerebellum; D, D, Spinal Cord.

and branches of a tree. The cerebellum is about one eighth the size of the large brain (Fig. 43).

7. **THE MEDULLA OBLONGATA.**—From the front part of the little brain, and from the under part of the brain proper, proceed a collection of fibers or little cords, which are all joined together and go into the spinal column. This is called the *medulla oblongata* (Fig. 43). At the base of the brain and above the place where the cord enters the spinal column are twelve pairs of nerves (Fig. 42). These nerves are round cords of a glistening white appearance, and are well protected from injury. When the cord enters the spinal column it is called the *spinal cord*, or the *spinal marrow*. It is contained in the holes which we have seen make a tunnel down the backbone of the skeleton. The gray and white matter in the spinal cord is the same as the gray and white matter found in the brain, and its substance is so soft that it needs protection along the whole of its course. Ac-

cordingly we find that the bones are so arranged as to shield this substance from injury in the same way as the brain is protected by the skull.

8. **Arrangement of Spinal Nerves.** — The spinal nerves, thirty-one pairs in number (Fig. 39), spring from each side of the cord by two roots, an *anterior* and a *posterior* root. From these spinal nerves other nerves branch out, growing smaller and smaller to the most remote parts of the body. Although where these nerves end they are finer than a hair and there are so many of them that they never have been counted, it is likely that each one goes from its origin in the brain or elsewhere directly to the part it is intended to protect, because we always locate or feel the pain in the part which has been injured. The message is never carried incorrectly.

9. **The Telegraphic System.**—Perhaps we shall understand more clearly how the nerves take messages to the brain and back again if our nervous system is compared to the telegraphic system. The brain is the principal office; the nerves branching from it to all parts of the body are like the wires which go from the main office to the stores and houses, to carry messages back and forth. These messages are constantly sent by the nerves to the brain and back again from all parts of the body. If you put your hand too near the fire, or on a hot stove, the nerves under the skin tell the brain, and a message at once comes back by other nerves to the muscles to take the hand away. These messages travel so rapidly that we are spared much suffering. We step on a nail. As soon as the point touches the foot the nerves telegraph to the

brain, and the brain orders the foot off so quickly that it is very slightly injured. It sometimes happens that the message is not given in time and a sore foot is the result.

10. Reflex Action.—The spinal cord not only carries messages to the brain, but also stops them on the way, as messages are stopped at the little telegraph-offices on the way to the main office. All along the spinal cord are these little offices, which take messages and send back answers, without consulting the brain. We have seen persons, when they were asleep, put up their hands to brush off flies that were troubling them, and yet not waken. If you tickle the feet or body of a person who is asleep he moves to get away from the tickling without waking up. After the head of a chicken has been cut off, the body will jump about for some time. This unconscious action is called the *reflex action* of the cord.

11. The Uses of Reflex Action.—Reflex action is important to us in our sleeping and our waking hours. It is our unseen protection, never weary and never needing sleep. It watches over us when our brains need rest, and keeps us from danger or death. The work of digestion is constantly going on, though we never think of it. Our hearts are beating while we are asleep as well as while we are awake; and we breathe without troubling ourselves about it. All these movements are caused by reflex action, and our brain is thus saved a vast amount of work. If we had to think about all these things, we should be soon tired of life, or we should forget them and should die. Our brains could have no rest, for we could never sleep. We should always have to be on the watch to keep our bodies alive.

12. **The Health of the Nervous System.**—It is important for us to learn how to take good care of our nervous system, that we may be strong and healthy, instead of sickly and nervous. We very often hear persons complain of being nervous. What causes it? It is often caused by indigestion. We may eat too much, or eat things that are not good for us. The stomach being unable to digest them, the brain either becomes dull and stupid, or the person will be cross, or "nervous," as people say. A lady said some time ago that it was very easy now to excuse persons when they were cross by saying they were nervous; but when she was young, people called things by their right names, and nervousness was temper. She was partly right and partly wrong. If our nerves are upset by indigestion, it is very hard to keep our temper. We feel cross, and we act as we feel. If we will always keep our stomachs in good order, there will be less cause for nervousness.

13. **The Brain.**—The brain is the thinking organ. It needs exercise as well as any other part of the body, and we should be just as careful to train it to right habits of thinking, as we should be to give good food to the stomach. While you are children your parents and teachers can advise you what to read, and how you may best study the wonders of the world about you. Animals and their habits will interest you. The study of plants and their uses will delight you. History is both interesting and useful.

14. **Mental Discipline.**—You should not only read books that treat upon these subjects, but talk about them

with persons who know more than you do. In this way you will fill your minds with useful knowledge. You should also learn to control your tempers, appetites, and passions while you are young. Self-control is what many grown persons have never learned; and though you may find it hard at first, you will succeed if you are determined to do so, and in after-life you will be much better and happier for it.

15. **The Need for Sleep.**—Sleep is very necessary to life and health. One of the worst punishments that the cruelty of man has invented is death from want of sleep. A prisoner who is condemned to die in that way is watched night and day by men whose business it is to see that he does not get a moment's sleep. Whenever he shows any disposition to go to sleep, he is forbidden, until at last death comes to his relief. While we are awake, our muscles, nerves, and brain are constantly active. Sleep is therefore needed to give our tired bodies a chance to rest and to repair the waste of the tissues. Sleep has been called "the image of death." Only the stopping of the action of the heart for a short time is needed to make it death.

16. **Time to Sleep.**—The most natural and for that reason the best time for sleep is at night. Then all the world is still, and most animals rest. People who are obliged to work all night and sleep during the day cannot feel as well as those who sleep at night. They look tired and worried, instead of being bright and rested. The number of hours needed for sleep is not the same for all persons. Eight hours for a grown person is the

usual number. A man who works with his brain requires more rest than one who works with his hands. Napoleon, and Frederick the Great slept only about four hours out of the twenty-four. Young people need ten or twelve hours' sleep, because their bodies are growing so fast, that besides the time needed to repair the waste, more time is required to supply the material for growth. If they sit up late, attend parties, and eat late suppers, they can never feel fresh and well in the morning, and will grow up to be pale and nervous men and women.

17. **Effects of Alcohol on the Nervous System.**—Alcohol taken into the stomach affects the nerves and brain at once. The face is flushed, because the nerves have lost the power to control the flow of blood through the body. The brain is thus excited, and words come very freely, so that some persons, knowing this, often take a little wine as a stimulant to enable them to talk better in company. If much wine be taken, the speech becomes thick and hesitating, the head dizzy; instead of walking they stagger along, and losing at last all control over the muscles, fall down and unable to rise, lie in a drunken sleep, making themselves objects of disgust to many, and of pity to not a few.

18. **Alcohol and Habit.**—One of the worst results of drinking intoxicating liquors is the loss of self-control. When one becomes a slave to the habit, he can seldom break it off. His self-respect is lost, and if only given enough to drink he is easily led into any vice or crime which his associates choose. Alcohol is the cause of most of the murders and other horrible crimes with the ac-

counts of which our daily papers are filled. So long as the whiskey trade continues crime will increase.

19. **Delirium Tremens.**—Delirium tremens is one of the most horrible effects of hard drinking. The person so affected fancies he is covered with all sorts of horrible creatures. Snakes seem to be crawling over him, and reptiles of all kinds torment him, while he strives in vain to throw them off. He cries, shrieks, and jumps, to get out of their way, begging all who are about him to help him. At last he sinks down exhausted, only to begin the same struggles again, when the delirium returns.

20. **Inherited Appetite for Alcohol.**—The taste for alcohol is often inherited, and the drunkard's child may have a taste for the poison which has ruined the parent. We all ought to be sorry for those who are slaves to this vice, and to use every means in our power to reform them. Boys often laugh at and torment drunken men, but if you are tempted to do it, remember that they were boys once, as young and happy as you are, and think what has degraded them. They are now what you will be, if you indulge the love for drink that has brought them into this terrible condition.

21. **Tobacco.**—Tobacco is smoked, chewed, and used as snuff. In whatever manner it is used, it is hurtful. Most persons who use it are injured by it in one way or another. There is a poison, called *nicotine*, contained in tobacco, and it is this poison which causes nausea, vomiting, and dizziness when persons first begin to chew or smoke. Many a boy who thinks it is manly to smoke finds, when he tries it, that he is well punished for his

foolishness. Although his first cigar makes him very sick, he dares not go to his mother or father to complain, knowing that he has disobeyed them and must take the consequences.

22. **How Tobacco Affects the Heart.**—Tobacco often affects the action of the heart in grown persons who use it freely. It produces indigestion, and causes the hands to tremble like those of a hard drinker. Is it not better for boys not to form such a habit than to try to break themselves of it when they are suffering from the effects of the poison? Cigarettes are even more injurious than cigars, as when using them a larger amount of smoke is taken to the lungs. Snuff-taking is injurious to the senses of smell and taste, and to the voice.

23. **Opium.**—Opium is the thickened juice of the poppy plant of India and is a very important medicine. It relieves pain and puts to sleep persons who are wakeful or suffering. Opium is dangerous in the hands of ignorant or careless persons, as too large or too frequent doses have often put them into so deep a sleep that they could not be wakened—the sleep of death.

24. **Opium-eating.**—Some persons indulge in opium to relieve pain, until they form for it a taste that, like the craving for whiskey, is almost impossible to overcome. Such people are called opium-eaters. Although often told that if they continue to eat opium death is certain, such slaves are they to the habit that they will take any means to gratify their desire for it. The effort to give up its use causes the utmost misery. Promises are broken, and only forcible and long-continued restraint will effect a

cure. Many men would give all they possess to be able to break themselves of the habit, yet the craving for this poison is too strong to be resisted.

QUESTIONS.

1. What are called vegetative functions? 95
2. Compare our bodies to trees and plants. 95
3. How is the sap like the blood? 95
4. How are the leaves like the lungs? . . . 95
5. What is vegetable respiration? 95
6. What powers have we that plants have not? . . 95
7. What is that servant that warns us of danger called? . 97
8. What are the principal parts of this system? . . 97
9. Compare it to the telegraphic system. . . . 97
10. Where is the brain situated? 97
11. What is its shape? How is it divided? . . . 97
12. How does it look? How much does it weigh? . . 97
13. How much did the brains of Daniel Webster and Agassiz weigh? How much does an idiot's brain weigh? . 97
14. What is to be considered besides the size? . . 97
15. What is the cerebrum? 98
16. Into how many parts is it divided? . . . 98
17. How is the outside marked? What is the color? . . 98
18. What does this gray matter contain? How thick is it? . 98
19. What is under the gray matter! 98
20. What is the cerebellum? How is it divided? . . 98
21. Describe its ridges? How large is it? . . . 98
22. What is the medulla oblongata? 100
23. How many pairs of nerves are there above where the cord enters the spinal marrow? 100
24. How do they look? 100
25. What is the spinal cord? What protects it? . . 100
26. What is its color? 100
27. How many pairs of nerves proceed from the spinal cord? 101
28. How are these connected with other nerves? . . . 101
29. Why do we feel pain in that part of the body which is hurt? 101
30. To what can our nervous system be compared? What is its principal office? 101
31. To what can you compare the wires? . . . 101
32. How do the nerves prevent accidents? . . . 101
33. Does every message go to the brain? , . . 102

34. Give examples of action during sleep. . . . 102
35. When the head of a chicken is cut off is the body at once still? 102
36. What is reflex action? 102
37. How does it protect the body from injury? . . . 102
38. What can you say of digestion and breathing? . . 102
39. How does reflex action benefit us? 103
40. What often causes nervousness? 103
41. Are you likely to be pleasant and kind to others when your nerves are disturbed by indigestion? . . . 103
42. What is the brain? 103
43. Does it need exercise? Why? 103
44. What is its office? 103
45. How can you give it good food? 103
46. Why should we learn self-control? . . . 104
47. Is sleep necessary to our health? 104
48. What very cruel punishment can you mention? . . 104
49. Why do we need sleep? 104
50. How is sleep like death? 104
51. What is the best time for sleep? Why? . . . 104
52. Are people who sleep in the daytime as well as those who sleep at night? 104
53. How many hours do grown people generally need for sleep? 104
54. How many hours a day did Napoleon and Frederick the Great sleep? 105
55. How much time do children need for sleep? . . 105
56. What is the effect of sitting up late at night? . . 105
57. Does alcohol taken into the stomach effect the brain? How? 105
58. What is the effect when a large quantity is taken? . . 105
59. Is it easy to break off from the habit of drinking? . 105
60. Why is it easy to lead a man into crime who drinks too much ? 105
61. What is delirium tremens? 106
62. How can persons avoid these evils? 106
63. Is the taste for strong drink inherited? . . . 106
64. Why should we be sorry for drunkards? . . . 106
65. Is tobacco hurtful? 106
66. What is the poison in it? 106
67. What effect does it have? 106–7
68. How does snuff injure one who takes it? . . . 107
69. What is opium? What is its use? . . . 107
70. What can you say of the habit of opium eating. . . 107

CHAPTER X.

The Five Senses.

1. We have already learned that the nerves, going from the brain to the fingers, toes, and to the surface of the body generally, give us the sense of feeling, or *sensation*, in those parts. If a nerve ending in the skin should be cut, so that it could not convey messages to the brain, we might be pinched, or pricked with a pin over the point served by that nerve without feeling pain. We say that we feel with our fingers, we hear with our ears, we taste with our tongues; but the fact is that the organ that perceives these sensations is the brain.

2. **Sensation.**—The sensibility, or feeling, in any parts of the body depends upon the number of nerves the part contains. The nails, the hair, and the scarf-skin have no nerves, so that they may be cut without giving us pain. The cutis, or true skin, which is, as we have learned, under the scarf-skin, is very sensitive, because it is full of nerves; but the muscles, cartilage, and bone have very little feeling. When a surgical operation is performed, like the cutting off of a leg or an arm, the most painful part of it is the cutting through the cutis, or true skin. If any way could be found to destroy the feeling in the cutis, the other parts would feel the cutting very little. Numbness is sometimes caused by throwing a spray of a liquid called ether upon the part to be cut. The ether

passes off in the form of vapor, so rapidly that it causes a feeling of intense cold, and as long as it is used destroys the feeling in that part, so that the patient will suffer very little, if any, pain from the operation.

3. **The Uses of Pain.**—We all know what pain is, for we have felt it. Grown persons, as well as boys and girls, often get impatient because they have to bear it. Have we ever thought that pain, although so hard to bear, has its uses? It acts as a protection to the body. If we hold the hand too near the fire, the pain we feel warns us to take it away at once. If it were not for the sense of pain, the hand might be kept there until it was severely burned, and we should not know it. Pain also warns us not to eat food that we cannot digest. If we do not heed the warning, we deserve to suffer. Persons stupefied by drink are often severely burned, or burned to death while in a drunken sleep.

4. **Special Senses.**—Besides the feeling of pain just described, there are other feelings which are subject to the will. These are called *special senses.* They are five in number—Touch, Taste, Smell, Sight, and Hearing. Special organs are furnished for them, as the hands for touching, the tongue for tasting, the nose for smelling, the eye for seeing, and the ear for hearing. No one of these organs can do anything but its own work. We never think of tasting with our eyes, or smelling with our ears.

5. **Touch.**—The sense of touch is given to the whole surface of the body, but is most delicate in the hands, and particularly in the tips of the fingers. If we pass our fingers over an object, even if we do not see it, we have

an idea at once of its size, shape, and form, and could tell it by the touch at any other time. In the blind this sense of touch is often educated, to such a degree that it almost takes the place of sight. They can read by passing the fingers rapidly over raised letters, and, by feeling a face, will know it again, as well as we do by seeing it. If you have never seen the letters of the blind, it would be an amusement to shut your eyes and try to learn them, as the blind do, by feeling them.

6. **Taste.**—The tongue is the special organ of taste. The back part of the mouth also possesses that sense. There are a great many muscles in the tongue, which allow it to move in all directions. If you put out your own tongue and look at it in the glass, you will see that it is rough. This roughness is caused by tiny raised spots called *pa-pil-læ*, which are abundantly supplied with the nerves of taste. Some are so small that they can be seen only under the microscope, and resemble the papillæ in the fingers and other parts of the body that have the sense of touch. By means of these papillæ, the tongue is able to taste, to feel, and to know the temperature of anything that is taken into the mouth.

7. **Papillæ.**—By looking at a dog's tongue, we can easily see that the papillæ are larger, and the tongue much rougher than in man. The same is true of horses, cows, and other animals. This rough surface enables the dog to lick the flesh off a bone which, as the muscles of his tongue are strong, he can very easily do. The lion also, by licking it with his tongue, can take the skin off any animal he has killed.

8. **Tastes in Different Climates.**—Taste is partly a

matter of education. A child's natural taste is simple. As he grows older, and eats with older persons, his taste changes, and he begins to like what they eat. Often he becomes very fond of the things that were disagreeable to him when he first tasted them. The Esquimaux like whale-oil and drink a great deal of it, for their climate is so cold that fat is needed in large quantities to furnish heat for their bodies. The Finns, we are told, will eat a tallow candle with as much relish as if it were a stick of candy.

Persons who go from our climate to a very cold one soon begin to eat and to like the same food as the natives themselves enjoy. The Persians are very fond of asafœtida, which we think very disgusting; and the Chinese consider as luxuries many articles of food that we never think of eating. The sense of taste can be cultivated until it is very wonderful, some men being able by the taste alone to tell the place from which tea has been brought.

9. **The Nose.**—The sense of smell is due to the nerves that end in the delicate membrane, or internal skin, that lines the openings or cavities of the nose (Fig. 44). The nose is formed partly of bone and partly of cartilage, or gristle, together with this covering membrane. The upper part of the nose is joined to the skull by

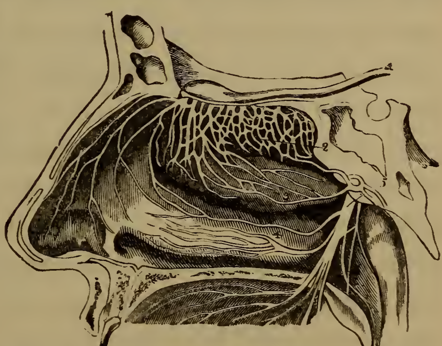

Fig. 44.—Section of the Right Nasal Cavity.

a few small bones. The lower part, or tip of the nose, contains several thin pieces of cartilage, which enable it to bear heavy blows without breaking. Behind the nose, in the upper and back part of the mouth, are two cavities called the nasal cavities. These have a delicate lining called the mucous membrane, which is kept moist by a fluid which it, in common with all mucous membranes, secretes. When we suffer from a cold in the head this membrane becomes dry and small, and the sense of smell is almost destroyed.

10. The Sense of Smell.—The sense of smell is more acute in some persons than in others. Some notice the least unpleasant odor; others never seem to notice bad odors, however offensive they may be. Dogs possess the sense of smell in a very high degree, and it can be cultivated so as to be very useful. A dog can tell the footsteps of his master from those of any other person. Give a dog a shoe which a lost child has worn and tell him to find the owner. He will smell the shoe, and then, with his nose to the ground, will hunt until he finds the scent of the footsteps of the child. That being found, he will follow the scent for miles until he discovers the child.

11. Uses of Smell.—Deer and other animals, when they are hunted by dogs, sometimes put their pursuers off the scent by going into a stream of water, and following the stream for a long distance. They appear to know that the hounds will be unable to scent their course in running water, and how far they must keep in the stream before it is safe to take to the woods again. Smell, like

taste, aids us to select proper food and to avoid that which is spoiled and unfit to be eaten. It also warns us not to breathe gases and vapors that are unfit to be taken into the lungs, and which we might breathe, did not the sense of smell warn us to avoid them.

12. **Sight.**—By sight we mean that sense by which we learn the size, color, distance, and form of objects about us, with which we are in direct contact. We look at the faces of our friends or at a beautiful landscape; we read books or letters; we write, and we do a thousand other things that sight enables us to do. These things are so natural to us that we, perhaps, have never thought what a wonderful thing sight is, or how necessary it is to our comfort and pleasure.

13. **The Eye.**—The eye is the organ of sight. It is both a wonderful and beautiful thing. It is a wise arrangement of our Creator that there are two eyes, so that if one should be destroyed, the other could do the work of both. The eye gives expression to the emotions; and by looking people in the eye we often know more about them than by any other way. A person may have a cruel eye that you shudder to look at; an eye that looks the sympathy which the heart feels, although not a word may be spoken; an honest eye, that tells you the man is to be trusted; a loving eye, that shows you the love with which the heart is filled. Surely the eye is, what it is often called, "the window of the soul."

14. **The Eyeball.**—The eyeball, which is a delicate organ, is well protected from injury by the bony sockets or holes in the head. If you place a book over the eye,

one end of which rests on the eyebrows, you will see that no part of the eye is touched. The bones project so as to protect it. The eyeball is round, except on the front, which projects beyond the rest (Fig. 45). Joined

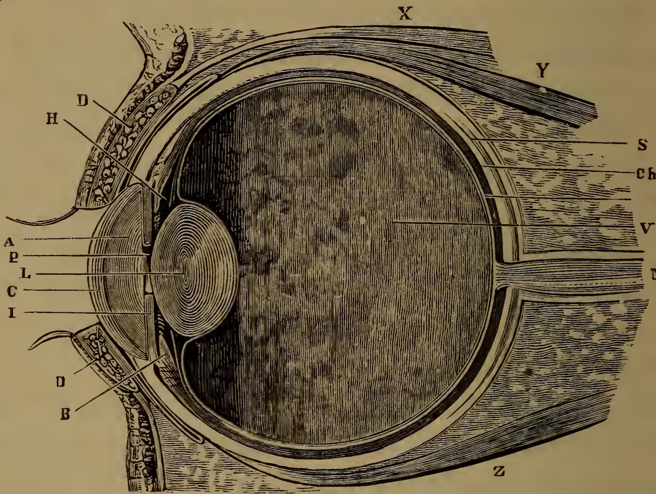

FIG. 45.—VERTICAL SECTION OF THE EYE. (Enlarged.)

C, The Cornea.
I, The Iris.
P, The Pupil.
L, The Crystalline Lens.
R, The Retina.
N, The Optic Nerve.
DD. The Eyelids.

to the back of the eyeball, as the stem is joined to the apple, is the optic nerve.

15. **THE RETINA.**—The optic nerve spreads over the inner surface of the eye, and is called the *retina*. Upon this, pictures of objects looked at are thrown, and remain for a few seconds, but gradually fade away. A bright light or color looked at for a few minutes cannot be lost sight of at once by closing the eyes. You seem to see it dimly, but in the same form as when your eyes were open. After a little time it fades away. The

spokes of a rapidly moving carriage-wheel look like a plane surface; a stick lighted at one end and whirled rapidly around, in the dark, looks like a ring of fire.

16. Color-blindness.—Some persons cannot tell one color from another. They cannot distinguish blue from green or red, and are called color-blind. Color-blindness is said to be the frequent cause of railroad accidents, because the engineer cannot tell the color of the signal on approaching it.

17. The Iris and Pupil.—The thin circular curtain that gives to the eye its color—blue, brown, gray, or black — is called the *iris* (Fig. 46). In the centre of the iris is a round opening called the *pupil*. This grows larger or smaller, as we are in a dark or light room. When we go from a very light to a dark room we can see nothing plainly, but as the pupil expands, or grows larger, more light enters the eye, and we begin to see objects more distinctly.

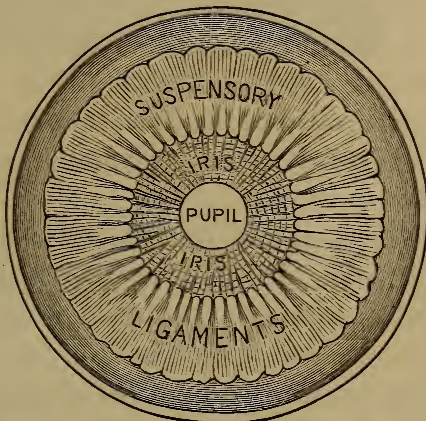

Fig. 46. — Front Section of the Eyeball, viewed from behind, and showing Suspensory Ligament, Iris, and Pupil.

18. Effect of Light on the Pupil.—As we suddenly go again to the light, so much of it enters the eye that we are dazzled, until the pupil again contracts, and we again see plainly. If you will take one of your play-

mates into a dark room, you will see that, in a short time, the pupils of his eyes will grow very large. Bring him into the light again and they will get as small as they were before he entered the dark room. Persons injure their eyes very much, and sometimes become blind by gazing too long at a bright object like the sun.

19. **The Cornea.**—The front part of the eyeball projects somewhat and has for its protection a transparent substance in shape like a watch crystal. This is called the *cornea*, and is the sole window by which light enters the eye. In health it is beautifully clear and bright; and so thin and delicate is it that you cannot see it in your own eye looking straight at it in a mirror. But if a person stand with the side of his face towards you and you look closely at his eye, you can see this little bulging window-pane.

20. **Shape of Cornea, and Sight.**—The cornea may bulge too much. You will see this in some people who, when reading a book, find it necessary to hold it very much closer to the eye than you do. This is because of the too great bulge of the cornea and is one of the causes of *near-sightedness.* On the other hand, if the cornea is too flat, objects that are held close to the eye are not seen clearly. A person is then said to be far-sighted. In either of these cases eye-glasses ought to be used, even for young children.

21. **The Crystalline Lens.**—Across the front of the eye, just behind the iris, is something which looks like a small lemon-drop; it is about a quarter of an inch thick, and is called the *crystalline lens.* If you will place a magnifying-glass at a window of a darkened room, and

hold a piece of paper behind it, you will see, upon the paper, a picture of what is going on outside, but the images in the picture will be inverted, or upside down (Fig. 47). People will seem to be walking with their heads

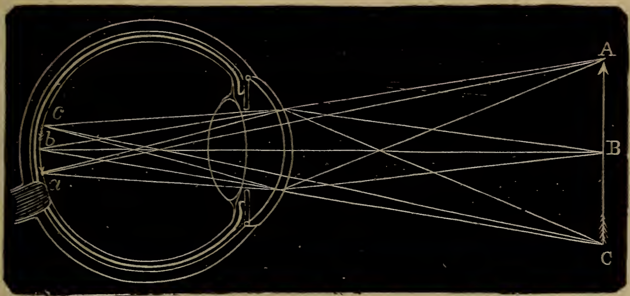

FIG. 47.—THE RETINAL IMAGE.

down and their feet up, and houses will seem to be hanging from the ground above them, instead of standing on it. This is called an inverted image of the objects you see. In the same way the rays of light pass through the crystalline lens, and are brought together in a point called the *fo-cus*, at the surface of the retina, and form an inverted picture there.

22. **THE INVERTED IMAGE.**—You will ask, if the image on the retina is inverted, how does it happen that our mind sees it in its right position? That is a question to which there is no satisfactory answer. It may be that, as we know our own place upon the ground and as we stand upright, we learn to know what is the real position of objects, and thus give them their true place.

23. **THE EYEBROWS AND EYELIDS.**—The hairy arches just above the eyes, which prevent the perspiration from running into them and protect them from dust, are the

eyebrows. The movable curtains which, when shut, cover the eye entirely, are the *eyelids.* The upper lid is larger and more easily moved than the lower one. A firm mucous membrane lines the eyelids, and is so sensitive that the smallest bit of sand or dirt in the eye causes a flow of tears and a great deal of pain, until it is removed.

24. The Eyelashes.—The hairs which are on the edge of the eyelids, and which with the eyelids help to protect the eye from dust and other things that would injure it, are the *eyelashes.* The lashes also help to regulate the quantity of light that enters the eye. Close to the lashes there are little glands which furnish an oil that prevents the lids from sticking together when they are closed in sleep.

25. The Lachrymal Gland.—At the upper and outer side of the orbit is a gland from which the tears come, and which is called the *lach-ry-mal gland* (Fig. 48). The tears keep the eyeball moist and clean, because they constantly pass across it. When we get anything in the eye which makes the tears run, we keep blowing the nose. This is because the tears have passed through by a little pipe called the *nasal duct.* The moisture that is not needed for the eyes is carried off by this duct. When we are ex-

Fig. 48.—Front View of Right Eye. (Natural size.)

1. The Lachrymal, or Tear-gland, lying beneath the upper eyelid.
2. The Nasal Duct is shown by the dotted line. The * marks the orifice in the lower lid.

The central black spot is the *pupil* ; surrounding it is the *iris* ; and the triangular white spaces are the visible portion of the *sclerotic.*

cited or grieved the tears sometimes overflow the lower eyelid.

26. **Care of the Eyes.**—Most persons are very careless in using the eyes. They read or sew without having light enough to see plainly what they are doing. They read too fine print, or read so long that their eyes become red and painful. Some persons injure their eyes by reading in bed, when they ought to be asleep. Foolish boys or girls also read by moonlight or firelight. The light should not shine directly upon the eyes when we are reading or sewing. If a shade is not worn, we should sit with the back to the light which should fall upon the book or the work, and not upon the eyes. If the eyes begin to pain us, it is best to rest them. By neglecting to do this persons have had trouble with their eyes all their lives, and some have even become blind.

27. **Hearing.**—When we have thrown a stone into smooth water, we have seen a circular wave set in motion from the point where the stone struck the water, and have watched it growing gradually larger. Somewhat like this is the wave of motion in the air. If we strike a bell, the air about it is set in motion. This motion extends to the air beyond it, until at last it reaches the ear and sound is heard. Sound is an impression made upon the ear by the vibration of the air caused by a moving body. Hearing is the special sense by which we are made acquainted with sound.

28. **Solids Convey Sound.**—Solid substances convey sounds more distinctly than they are conveyed by the air. You will find this to be true if you place your ear at one

end of a long beam, and let one of your playmates scratch the other end with a pin. You will hear the scratching very plainly.

The Indians by putting their ears to the ground can hear a troop of horsemen coming, although they are far out of sight, and can tell the difference between their tread and that of a herd of buffaloes.

29. Air Necessary to Sound.—Sound cannot be produced when there is no air. If all the air be pumped out of a tube or jar and we try to ring a bell in it, the clapper will move, but we can hear no sound. If the air be let in again, the bell will ring clearly. How thankful we should be that we can see the faces of our friends and hear their voices! If both sight and hearing were taken from us, how great would be our loss!

30. The Ear.—In order to study the organ of hearing, it is necessary to divide the ear into three parts—the outer, the middle, and the inner ear (Fig. 49). The *outer ear* is the part we see. It is a beautifully formed plate of cartilage covered with skin, and is somewhat trumpet-shaped, so that it can collect sounds and direct them inward. There is a little tube an inch and a quarter long, which connects the outer with the middle ear, and across the lower end of the tube a thin membrane is stretched, like the head of a drum, which divides the outer from the middle ear.

31. The Ear-drum.—This membrane is so thin and delicate that it can be easily broken, and if broken the hearing will be injured. The lining membrane of this tube has little glands, which secrete a yellow, bitter sub-

stance, called "ear-wax," which is a protection against such small insects as are liable to find their way into the outer ear. The middle ear is a small cavity about a quarter of an inch across and half an inch long (Fig. 50). From the peculiar arrangement of its different parts it

FIG. 49.—THE EAR AND ITS DIFFERENT PARTS.

A, Diagram of the Ear.
a, *b*, External Ear. *d*, Middle Ear.
c, The Tympanum. *e*, Internal Ear.
B to B‴, Bones of the Middle Ear (magnified).
C, The Labyrinth, or Internal Ear (highly magnified).

is called the *tympanum*, or drum of the ear. The thin membrane that separates it from the outer ear is the drum-head. This membrane is very thin and elastic, so that every wave of sound that touches it causes it to vibrate, as a drum-head vibrates when it is struck.

32. THE MIDDLE EAR.—Within this drum, and stretched across it, are three tiny little bones, one of which moves. Small as these bones are, they have their muscles, carti-

lages, and blood-vessels as nicely arranged as are those in the larger bones of the body (Fig. 51). One of these little bones is attached to the drum-head, another to the opposite side of the drum, while the third swings between them. As the waves of sound strike the head of the drum, they move these little bones and cause the motion to be sent forward to the inner ear. The drum contains air, which gets into it through an opening or narrow canal called

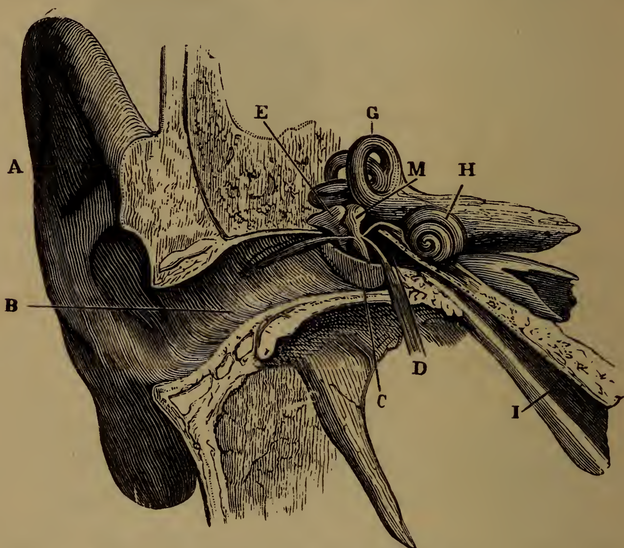

FIG. 50.—SECTION OF THE RIGHT EAR.

A, The Concha.
B, Auditory Canal.
C, Membrane of the Drum (the lower half).
D, A Small Muscle.
E, Incus, or Anvil.
M, Malleus, or Mallet.
I, Eustachian Tube.
G, Semicircular Canals.
H, Cochlea, or Snail's Shell.

the *Eustachian tube*, which opens into the throat. This tube also carries off the fluids which form in the drum. When the lining membrane of this tube becomes thick-

ened, as it does sometimes when we "take cold" in the head, these fluids may be locked up temporarily, and thus may hinder the waves of sound; when this is the case, we are said to be "hard of hearing."

33. **The Internal Ear, or Labyrinth.**—The inner ear is a bony case of tiny winding chambers and spiral tubes hollowed out in the solid bone. From its winding shape it is called the *labyrinth.* These passages are lined with a delicate bag of membrane, which partly fills the

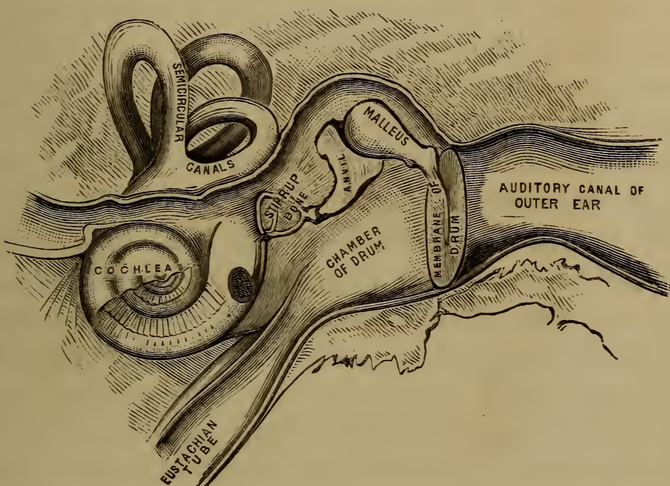

Fig. 51.—Showing the Internal Mechanism of the Ear (greatly enlarged).

cavity. The bag is filled with and also surrounded by a clear fluid in which it floats. The fibers of the *auditory nerve*, which passes from the brain to the inner ear, are spread out over the inner surface of this bag. By means of this auditory nerve the impression of sound is made on the brain.

34. **Care of the Ear.**—Great care should be taken of the ear if we wish the hearing to be good. Cold water should never be put into the ear, and if, after bathing, there is water in the ear, we should hold the head to one side and pull the ear open, so that the water may run out. A neglect of these directions may lead to deafness. Cold air coming through a crack in the door or window into the ear may cause deafness. If it is necessary to put anything into the ears or to syringe them with water let the water be first warmed. It is dangerous to put cotton into the ears to protect them from cold. The ear is only made more sensitive by it, and the hearing is injured. Never put pins or ear-picks or anything made of wood or metal into the ear to get out the wax. All such things are likely to do harm.

35. **To Remove Objects from the Ear.**—If a foreign body, like a pea, a bean, or a little stone should get into the ear, syringe the ear carefully with warm water, turning the head a little to one side. The overflowing of the water will usually bring it out. If a fly or some other insect should get into the ear, fill the ear with oil or soap suds that have first been warmed, in order to kill it. Then turn that side of the head down. The insect and the fluid will usually come out together. If they do not, syringe the ear, as mentioned above. It is well to remember this direction, as it may be of service. Some years ago a lady, who was a long distance from home, got a fly into her ear. The buzzing annoyed her very much, and not knowing how to get it out, she traveled more than a hundred miles to have it removed by her physician.

36. Caution.—A hard blow or "box" upon the ear given with the hand may produce deafness. It will not do to trifle with a delicate structure like the ear. We cannot be too careful of our ears and our eyes, as these are the organs through which we get the most of our knowledge and pleasure. Sight conveys to us the beauties of the world about us. Hearing brings us in contact with the minds of others.

QUESTIONS.

1. If the nerves could be cut so that they could not communicate with the brain, how would it effect us? . . 110
2. What is the organ of feeling? 110
3. Upon what does the sensibility of the body depend? . 110
4. Can the hair, nails and scarf-skin feel? Why not? . 110
5. What is the sensitive part of the skin? . . . 110
6. Could a surgical operation be performed without pain if we could destroy all feeling in the cutio? Why? . . 110
7. How is pain made useful to us? 111
8. What accidents sometimes happen to men when they are in a drunken sleep? 111
9. How are you warned not to eat too much? . . 111
10. What do you mean by special senses? . . . 111
11. How many and what are they? 111
12. Where is the sense of touch most acute? . . . 111
13. How does it take the place of sight in the blind? . 112
14. What is the special organ of taste? 112
15. Why are there so many muscles in the tongue? . . 112
16. What are the papillae? 112
17. What is their use? 112
18. What can you say about the papallae in the lower animals? . 112
19. Is taste a matter of education? Give examples. . 113
20. How does it depend on climate? 113
21. What do the inhabitants of cold climates prefer to eat and drink? 113
22. How far can the sense of taste be cultivated? . . 113

APPENDIX.

Emergencies.

"The readiness is all."—HAMLET.

The life of many a child has been saved by the fire-drill in schools, and great good has been done on shipboard by a drilling of the crews.

If in a building filled with smoke, get down on hands and knees and crawl to door or window.

In a cellar, well, or vat where carbonic acid can collect, the true posture is to stand erect. If a candle, on being lowered into a suspected place, is put out, you may know that there is danger to human life.

Burns and Scalds.—The secret of the best treatment of these injuries is to exclude the air from the wounded surfaces. When they are slight, and the skin is not destroyed but merely blistered, prevent as much as possible the displacement of the skin. Let the blisters be punctured, if necessary, to let out the liquid, and then keep the skin in place by cotton cloth or lint, wet with a solution of one teaspoonful of carbolic acid in a quart of water, or a strong solution of baking-soda. The cloth should be kept wet constantly, but do not irritate the wound by taking off the dressing too often.

Extensive burns are much worse than deep burns. In the former case, the outlook is grave, and the patient will probably require the best aid, both medical and surgical, of some physician.

Scars after Burns.—If a burn be on the face, neck, or near a joint, it is not well to hasten the healing process, on account of the contraction that always takes place as the scar is formed.

"**Fire** is a source of danger, and at times is very destructive to life. Spontaneous combustion of the human body when saturated with alcohol is a myth, though perhaps the alcoholized body does burn more readily than one free from inflammable fluid. When a lady is on fire, she should not run, as running fans the flames amazingly. She must be laid down, and rolled up in the nearest woolen article,—rug, coat, or blanket. Such wrapping-up in a non-inflammable article is a most effective method of extinguishing the flames. Immersion in water is, unfortunately, rarely practicable."—*Fothergill.*

Illuminating Gas is dangerous in two ways. If it escapes into a tightly closed room in sufficient quantities, it causes the death of the inmates by suffocation, unless some one from without discovers the perilous situation. If not too late, remove the patient into fresh air, undo the clothing, dash cold water on the face and neck, and employ artificial respiration, as in drowning (see p. 135). Again : if the gas escapes freely into an apartment, it forms an explosive compound by mixing with the air. If then a light is unguardedly taken into the place, an explosion that may be destructive to life will result. Always thoroughly air any room that has the odor of escaping gas before a light is taken in.

Kerosene is the cause of even more "accidents" than gas. Too much care cannot be taken in its use. Buy only that which has been tested, but remember that not all the brands that are marked as "safe" are truly so. If a responsible oil-man certifies that the oil will not "flash" under 140°, it may be regarded as safe if properly used. Lamps should be filled only in the daytime. Never attempt to fill a lamp that is lighted, and never put kerosene in the stove for the purpose of kindling a fire. Very small lamps are dangerous, as also is a lamp that has burned a long time, and has but very little oil in it.

Frost-bites.—Keep away from the fire and in a cool room. Rub

the nose or other part that has been "bitten" with snow or ice-water until the blood is again warm and circulating in the part. With chilblains do not go near the fire; if the skin is unbroken, it should be hardened by brushing it over with alcohol having tannin in it.

Cuts.—These, if severe, should be promptly attended by a physician, but every one should know how to treat small wounds. Learn the difference between the two kinds of bleeding, called "arterial" and "venous." Arterial blood is bright red, and comes in jets (or with throbs corresponding to the pulse); venous blood is dark-colored, and flows continuously. When an artery is cut, press on that side of the wound nearer to the heart; when a vein is cut, on the side away from the heart. Or, pressure may be made over the wound itself with the fingers: this may stop the loss of blood from small arteries as well as from veins. Loss of blood from arteries is apt to be more rapid and dangerous than that from veins; and when the cut vessel is a large one, the skill of the surgeon will ordinarily be required in order to close the bleeding artery permanently and securely.

It is well, in every household, to have, in some handy and well-known place, some strips of old muslin and some lint, or oakum, a bandage or two, and some adhesive plaster, a soft sponge, and needles and thread in a basket or box by themselves. In this way, valuable time may be saved in the stanching of blood, flowing in consequence of some accidental cut or other injury.

Fits or Convulsions.—These may be trivial or grave. If it is a young woman, the attack is probably hysterical, and, as a rule, not dangerous: a sprinkle of cold water will bring relief. If the patient struggles with regularity of movement, and there is a bloody froth on the lips, it is a case of epilepsy, and requires a physician's attendance. Meanwhile, protect the head from injury by putting a pillow or some soft article beneath it; a cork introduced between the teeth will prevent the biting of the tongue. Prevent the person from falling or injuring himself, but do not attempt forcibly to hold him quiet.

In children, apply cloths dipped in water to the head ; disturb the child as little as possible ; do not use a warm bath until directed to do so by the doctor.

Fainting.—This occurs when the blood is deficient in the brain. The proper position for one in a faint, therefore, is on his back. Let the window be opened to admit fresh air ; fanning and the sprinkling of water are useful. If the clothing about the chest is tight, let it be loosened. If the faint occurs at church or some public gathering, remove the person promptly to the outer air ; for foul air is frequently the cause of the trouble.

Vertigo.—This is "a rush of blood to the brain." The body should be placed in the sitting posture, with the head erect. If the blood escapes into the brain by reason of the rupture of a blood-vessel within it, the case is very grave, and the physician should be summoned at once. Meanwhile, let the position of the body be as above stated. Apoplexy is known, in very many cases, by the helpless condition of an arm or leg, or both.

Sunstroke is seldom produced in this climate in persons who have not labored too hard. Fatigue and sun-heat are commonly the joint causes of sudden prostration in summer; although "heat-stroke" may occur in an artificially heated atmosphere, without exposure to the sun. In the tropics, there is the least possible exertion by the natives during the mid-day hours. On very hot days, therefore, avoid fatigue and labor in the open air as much as possible. Keep the head cool. If any unusual, dizzy feeling comes on, apply cold water to the head and neck. If a person falls unconscious and the skin is decidedly hot and dry, he should be taken to a cool place. If the face and head are red and hot, apply ice-water on cloths. If pale, give stimulants gradually and use cold water sparingly.

Shock may be caused by a fall or by a blow upon the head or on the pit of the stomach. It is known by slowing of the pulse and respiration ; the face is pale and the skin becomes cool. The head should be placed low, some ammonia in water be given, and warmth applied to the surface of the body.

Drowning.

MARSHALL HALL'S "READY METHOD" of treatment in asphyxia from drowning, chloroform, coal-gas, etc.

1st. Treat the patient *instantly on the spot*, in the *open air*, freely exposing the face, neck, and chest to the breeze, except in severe weather.

2d. In order *to clear the throat*, place the patient gently on the face, with one wrist under the forehead, that all fluid, and the tongue itself, may fall forward, and leave the entrance into the windpipe free.

3d. *To excite respiration*, turn the patient slightly on his side, and apply some irritating or stimulating agent to the nostrils, as *veratrine*, *dilute ammonia*, etc.

4th. Make the face warm by brisk friction; then dash cold water upon it.

5th. If not successful, lose no time; but, *to imitate respiration*, place the patient on his face, and turn the body gently, but completely, *on the side, and a little beyond;* then again on the face, and so on, alternately. Repeat these movements deliberately and perseveringly, *fifteen times only* in a minute. (When the patient lies on the thorax, this cavity is *compressed* by the weight of the body, and *ex*piration takes place. When he is turned on the side, this pressure is removed, and *in*spiration occurs.)

6th. When the prone position is resumed, make a uniform and efficient pressure *along the spine*, removing the pressure immediately, before rotation on the side. (The pressure augments the *ex*piration; the rotation commences *in*spiration.) Continue these measures.

7th. Rub the limbs *upward*, with *firm pressure* and with *energy*. (The object being to aid the return of venous blood to the heart.)

8th. If possible, substitute for the patient's wet clothing such other covering as can be instantly procured, each bystander sup-

plying a coat or cloak, etc. Meantime, and from time to time, *to excite inspiration*, let the surface of the body be *slapped* briskly with the hand.

9th. Rub the body briskly till it is dry and warm, then dash *cold* water upon it, and repeat the rubbing.

Avoid the immediate removal of the patient, as it involves a *dangerous loss of time*—also, the use of bellows, or any *forcing* instrument; also, the *warm bath*, and *all rough treatment.*

The Home and Health.

The location of the house should be airy, dry, and sunny.

A certain amount of elevation is necessary, in order to secure proper drainage. Too much shade must not fall upon the house, as sunlight is very necessary to a proper degree of animal vigor. Young children, as is well known, especially profit by the tonic influence of sunlight.

The cellar is an important part of the dwelling; therefore, unless care be taken for its ample ventilation, it will be the source from which is supplied much of the air breathed in the upper chambers of the house. If the cellar is damp the house is liable to become so, and if vegetables are stored in the cellar, an especial degree of care is needed to ventilate it thoroughly and constantly.

House-drainage.—An English writer has stated that "the most important part of the house is the drains." This, no doubt, sounds strangely to the ears of many, who have been brought up to view the parlor or drawing-room as the true center of the house, and yet it is no foolish saying, when we reflect that with a bad system of drainage to a house every dweller therein stands in peril of several forms of disease that, mild as the cases may be, are a source of anxiety, and, when severe, too often have a fatal termination. Drain-diseases, such as typhoid fever, dysentery, diphtheria, and scarlet fever, often destroy entire families. These diseases do not always spring upon a home through defect-

ive drainage ; but when they do, they frequently show themselves in a very violent form.

Drainage, as applied to dwellings, consists in conveying away from the house the liquid and solid impurities that would otherwise accumulate in or near the dwelling. Waste is a necessary accompaniment of all animal life, to the preparation and the taking of food, to the clothing of the body, to bathing and other simple acts of daily life. The waste material of houses tends to decay and to become offensive. It must, therefore, not only be put out of sight and smell, but must be removed so far away that it cannot return in the form of dangerous, invisible gases of decomposition.

The best house-drains are made of iron or glazed earthenware, carefully selected and well laid. The joints of the pipes should be gas-tight. The soil-pipe should be carried up to and through the roof. All the waste-pipes from basins, etc., in the rooms should be joined in a gas-tight manner to the soil-pipe, and each and every basin and other fixture should have a separate trap. What is a trap ? It is a device that is designed to retain a certain portion of the water running through it—called the "water-seal" —so that the ascent of air or gas, from the drain back into the room, is prevented. It "traps" the sewer gas away from us. Whenever a fixture has been used, and there is not, beyond all doubt, a sufficiency of water to fill the trap, additional water should be poured in. Traps are of various sizes, and of an infinite variety of patterns and patents, and must vary greatly according to their situation ; but one thing should be made sure of in their use—namely, that they hold not less than two inches of water as a "seal."

There is at almost all seasons of the year an upward, because warmer, current of air through the main pipes. It is therefore better to have a fresh-air inlet pipe near the point where the drain leaves the house-wall. This helps to prevent the unsealing of traps. It also brings about a purer condition of the air in the interior of the system of pipes: so useful is this air-current

through the soil-pipe that if applied there is little danger of the escape of sewer gas into the living rooms.

What is sewer gas or sewer air? It varies greatly in different places and at different times. It is not a definite gas, like oxygen, nitrogen, etc., but varies in composition, and, what is still more worthy of note, it varies in its dangerous qualities. It is not always offensive, although it is generally so; its odor has been described as being "sweetish and sickish." Its dangerous qualities have not yet been determined by chemistry or the microscope; but one practical point may be borne in mind—namely, that when a case or cases of contagious disease occur in any house along any given line of sewer pipes, it is best to use disinfectants in the drainage of the other dwellings along the same line of sewer. Children should avoid at all times playing over or around the sewer gratings in the streets, and especially when scarlet fever and like contagions diseases are known to be in the neighborhood, for the exit of sewer air at these points is always very free, unless it be directly after a rainfall.

One other point must be remembered, that the best-laid system of house-plumbing is not indestructible. In the course of time, defects will arise, breaks will occur; for this reason it would be well for every householder to have at intervals an examination made of every joint and along the whole line of the house connection with the sewer or drain.

It is thought by many that sewer gas is not found in the country because there are no sewers: they have been misled by the word. If the words "drain air" or "filth gas" had been adopted, the universal production of this injurious substance, in close connection with every abode of man, wherever located, might have been better understood. In country houses there are, perhaps, fewer dangers of contamination of the air we breathe by waste products, because there are fewer water-closets, wash-basins, sinks, etc., and the rooms are less exposed to impure air.

But in the country danger is apt to come by or through the pollution of the water supply. The well, which furnishes that

cool and refreshing draught, is the point to be watched. It is convenient to have the well near the house, because when snow is on the ground, and the weather is cold, the distance to the well from the house is a matter of no small moment. Near the house must be the stable and pens for animals; the waste from the house goes upon the ground, and not very far away from the house; the chamber slops and the more offensive matters go into a pit, which must not be too distant. The result of all these conditions is a pollution of the soil at all these points—a pollution which spreads with every rainfall, and which, sooner or later, reaches the well; yet the water may appear as pure as ever. It only remains to have the suitable disease-germ lodged in this polluted territory to bring down the whole household with a fever. This is the kind of soil-pollution which is hard to cure, and which, in long-settled countries, causes laws to be enacted requiring all vaults for the reception of house and human waste to be made water-tight, so as to save the soil from its poisoning influence.

This is the kind of poisoning which, in the Dark Ages, caused so much unrighteous persecution of the innocent. In those days no care whatever was taken in the towns, high-walled, crowded, and unsewered, to protect the water supply from pollution. As a result, some terrible epidemic of fever would arise. Then the angry populace would, in their ignorance, cry out, "The Jews have poisoned the wells." The wells were poisoned, no doubt, but the Jew was no more worthy of blame than were his accusers. Nevertheless, the Jews were not spared; they were robbed, imprisoned, executed.

Drainage in the city is a comparatively easy problem when the city's sewers are laid in the streets. In the country it is more difficult, and on this account the fewer fixtures or "modern improvements" there are in the house the better it will be. There should be no less care within the country house, where waste-pipes are put in, than in the city house. The material should be well selected, tightly joined, and properly ventilated. The water-

closet should be remote from the house. Earth-closets are better than the ordinary vaults—house-waste from kitchen and laundry should be taken to a considerable distance from the house, and far away from the well, and either deposited in a water-tight cesspool or conveyed away, by a system of subsoil drainage tiles, arranged so as to fertilize some unoccupied plot of ground.

The Care of the Sick-room.

The sick-room should be bright and airy, and "Sweetness and light" its motto. Other things being equal, it is best on one of the upper floors; in the case of some "catching" disease, on the top floor. Let it be on the sunny side of the house. If for any reason the light of the sun is temporarily to be avoided—as when the eyes are sensitive or have been operated upon—let the light be shut out by a proper arrangement of blinds or curtains. The air-supply to be breathed by the sick person should be pure. Those who, in health, find themselves in an impure air can quit it; they are not compelled to suffer from it; but a sick person may be incapable of recognizing the bad quality of the air, as well as helpless to free himself from it.

To keep the air pure, the windows should be opened as often as three times a day, care being taken to protect the patient from being chilled while the room is being aired.

Unless the physician shall direct differently, one window—that most remote from the bed—should be open an inch or more both day and night, and in all seasons. The extent to which the sash shall be lowered must be governed largely by the weather and the direction of the wind.

A fire, in an open fireplace, except in summer weather, will be a great help towards keeping the air pure. The upward current through a chimney flue, if unobstructed, is equal to or not far below 20,000 cubic feet per hour: an outlet sufficient for a room occupied by ten persons.

The inlet of air, however, must not be forgotten, otherwise the air of the room tends to become both impure and rare. As

our houses are generally constructed, the inlet of air is best secured by a window-sash being lowered from the top.

Take special care that no stationary wash-basin or other sewer-connected convenience is improperly plumbed, and that sewer-gas cannot by any possibility escape into the sick-room.

The swinging of doors to create a current is not an efficient means of ventilation, as it agitates the air of the room without purifying it, and often disturbs the patient.

A draught of air is to be avoided ; it will seldom occur that the air of the room requires to be so speedily changed that the patient need be exposed to a draught ; never, when care has been taken to provide continuous and gradual ventilation.

It should be borne in mind that cold air is not necessarily pure air, and that ventilation is not less needed in winter than in warm weather.

Sleep is a great necessity to the sick. If a well person slumbers in the daytime, it will interfere with his sound repose at night ; but with the sick this is generally not the case. The more they sleep the more favorable are the chances for their recovery ; so that it will be readily seen how important it is to avoid noise and jar in the sick-room, especially if the disease is acute.

Bear in mind that even slight noises, as the rustling of garments, the creaking of doors, whispering, or noisy footfalls, may be sufficient to disturb a brain that is rendered sensitive by pain or wakefulness.

The clothing next the skin should be changed more frequently in sickness than in health. These changes must be quickly and deftly made, and with as little disturbance as possible.

Under some conditions of disease, the best welfare of the patient is accomplished by having two beds instead of one in the room.

The temperature of the room must be watched. To that end a thermometer should always be present, and easily approached. It is better not to have it directly in the view of the patient. The temperature should not be allowed to vary much from 65° F., unless the doctor otherwise directs.

Let the furniture be as plain and as free from upholstery as possible; not many pieces are required. Movable carpets or rugs are better than those that are permanently laid. Curtains about the windows are out of place in a sick-room; so are flowering plants and birds, as a general rule. Florence Nightingale, however, makes an exception in the case of chronic invalids, and consents to the comforting influence of a pet bird or two.

In regard to the admission of visitors and conversation, much will depend upon the strength of the patient and the kind of sickness; at many times these are to be forbidden, as having a disquieting influence. When contagious disease is in the house, the sick-room must be avoided by all except those who have the care of the patient, and those having this care should avoid coming in contact with the other members of the household, especially the children.

Bear in mind that everything brought in contact with the sick is liable to endanger the health of the well.

No articles in use by the invalid should be removed or used by others until thoroughly disinfected; the dishes and spoons should be put in boiling water before being taken from the room. The room itself should be fumigated with sulphur when the person is removed from it.

Old pieces of muslin, etc., may be used instead of handkerchiefs to receive the poisonous discharges from the nose, mouth, and throat. These can be destroyed by fire, and thus prevent the danger of conveying the disease to others.

"Taking the breath" and kissing should be avoided by those in attendance upon the case.

The bottles of medicine and other reminders of illness should, as far as convenient, be withdrawn from the view of the sick.

Such as are to be kept always at hand should be arranged in an orderly way upon a tidily covered bedside table. The sight of a siphon-bottle of aërated water is agreeable to most patients; that may be kept in the room, but the vessels containing milk, drinking-water, etc., should be kept elsewhere.

Disinfection.

Filth fosters or produces certain diseases; it should therefore be removed as soon as possible. When it is difficult to remove it, disinfectants come into play, as they have the power to rob it of some of its disease-making force. But let it be remembered that disinfection is not cure; it is not a substitute for cleanliness and pure air. The true cure is the removal of filth; and when our homes are concerned in some question of drainage where the filth is out of our sight, it may be necessary to consult and employ the plumber or some other artisan.

In times gone by, it was the custom to mask bad smells by burning pastiles, coffee, cascarilla, and the like. These are not now much used, for most persons have come to understand that the fumes thus created do not remove, but simply overpower, the evil odors.

Chemistry has advanced to such a point that various pungent chemical substances, formerly not well known, can be furnished at small cost, and these substances have the power, in varying degrees, to check vile odors. Carbolic acid, chloride of lime, and Labarraque's solution are among the best known of these; but there are also certain of the salts of iron and zinc, and the permanganate of potash, that may be used. Sulphur is much used for the fumigation of rooms that have been infected.

Another cheap disinfectant is a solution of chloride of lead. It is inodorous, effective, and the cost is small. Take half a drachm of the nitrate and dissolve it in a pint or more of boiling water. Dissolve two drachms of common salt in a pail or bucket of water; pour the two solutions together, and allow the sediment to sink. A cloth dipped in this solution and hung up in a room will correct a bad odor promptly; or if the solution be thrown down a drain or upon foul-smelling refuse, it will have the same effect.

The room to be purified with sulphur should be made as tight as possible, so that no fumes can escape, either by window, door,

or chimney. Put three pounds of sulphur in an iron pot, which should not stand upon woodwork or carpet, lest they be burned, but in a large pan of ashes, or upon a layer of bricks; on this sulphur pour a table-spoonful of alcohol. This is then set on fire, and everybody immediately withdraws from the room. The room should remain closed ten hours, after which it should be thoroughly aired before it is occupied, for the fumes of the sulphur are irritating to the lungs.

The chemicals above mentioned should be known and labeled as poisons. Many persons have been injured, if not killed, by incautiously or ignorantly drinking those that are of a liquid form.

Heat is one of the best, if not the best, disinfecting agent. Articles of bedding and furniture that cannot well be treated otherwise can be purified by a long exposure to a temperature of 240° F. In some cities, especially in England, furnaces are made for the reception of bulky articles that have become infected.

Fresh, pure air is another powerful agent. If woven fabrics, clothing, and the like are for a long time aired out of doors, they cease to be infective; probably by the enormous dilution, if not destruction, of the elements of danger.

Certain diseases are "catching;" they have the power of spreading from one person to another, chiefly by the particles that pass off from the body of the patient. Among these diseases are small-pox, measles, scarlet fever, and diphtheria. The articles that are worn or used by the patient become "infected," and they should be disinfected before they are used by others. As a rule, of course, a doctor will be called in to attend to these diseases. When that is so, follow his directions as to disinfection as well as every other part of the treatment of the case. For substances that are not injured by being washed, a good and cheap disinfectant is sulphate of zinc ("white vitriol") and common salt dissolved in water, boiling-hot if possible; using eight table-spoonfuls of the zinc and four of salt to the gallon of water. This is useful for clothing, bed-linen, towels, handkerchiefs, etc. After these articles have lain for an hour or two in this solution, they should be

allowed to stand in boiling water before being washed. Infected articles that are of little value should, of course, be destroyed by fire.

The United States Treasury Department has published the following formula for the disinfection of the rags coming from Egypt: "1. Boiling in water for two hours under a pressure of fifty pounds per square inch; 2. Boiling in water for four hours without pressure; or, 3. Subjection to the action of sulphur fumes for six hours, burning one and one half to two pounds of roll brimstone in each 1000 cubic feet of space, with the rags well scattered upon racks." Either of these three methods is accepted as sufficiently thorough to prevent the spreading of cholera by means of rags.

On Going into the Country.

To spend the summer in the country would be the choice of all city-dwellers whenever their purses will permit of it. And there are not a few advantages in such a course; the change of scene is good, the mountains and the seaside give a purer and cooler air—an air that invigorates and aids in restful sleep at night, so different from the midsummer atmosphere in hot cities. There are fewer excitements in the country; we do not "live so fast," and there is full scope for healthful life and activity in the open air, with the green and blue of nature all about us, instead of the monotonous walls of towering houses.

But this course, pleasant and helpful to so many, is not without its danger. Many who "go away" on vacation are brought home sick on account of fever or other diseases caused by defects and faults of drainage existing in these temporary summer homes. Scarcely a year goes by that one or more summer resorts have not gained the ill name of being the hotbeds of typhoid fever, dysentery, and the like.

In view of this, how important it becomes that we exercise judgment and seek skilled advice in the selection of our summering places!

10

Again, there is another danger that must not be overlooked. Let us suppose that the summer vacation has passed by without accident; that we return invigorated by the experience; and that the home in the city has been empty and closed during our absence; what has happened that the air in the rooms newly reopened should be foul and stifling? This has taken place: the water that stands in the traps of house pipes, and shuts off gases from the sewer when the rooms are in use and water is daily entering the different wash-basins, etc., has evaporated during our absence. For weeks, perhaps, there has been no "water-seal" in the traps, and the ascent of sewer air has been going on continuously, so that not only is the air utterly unfit to live in, but all the curtains, carpets, and other absorbing materials have become saturated with the pollution thus allowed to enter. Let it be remembered that when a sink, etc., is not in use, it is gradually losing the trap-water by the evaporation.

What is the remedy, you will ask, for the condition of things caused by closing up the house, as above stated? To this the reply is, that the house, while vacant, should from time to time be opened and aired, and water should be poured down each and every sanitary fixture, in sufficient quantity to renew the supply of water in the trap of each.

Poisons and their Antidotes.

Accidents from poisoning are of such frequent occurrence that every one should be able to administer the more common antidotes until the *services of a physician can be obtained.* As many poisons bear a close resemblance to articles in common use, no dangerous substance should be brought into the household without having the word *poison* plainly written or printed on the label; and any package, box, or vial without a label should be at once destroyed if the contents are not positively known.

When a healthy person is taken severely and *suddenly* ill *soon after some substance has been swallowed*, we may suspect that he has been poisoned. In all cases where poison has been taken into

the stomach, it should be quickly and thoroughly expelled by some active emetic, which can be speedily obtained. This may be accomplished by drinking a tumblerful of warm water containing either a table-spoonful of powdered mustard or of common salt, or two tea-spoonfuls of powdered alum in two table-spoonfuls of syrup. When vomiting has already taken place, it should be maintained by copious draughts of warm water or mucilaginous drinks, such as gum-water or flaxseed tea, and tickling the throat with the finger until there is reason to believe that all the poisonous substance has been driven from the stomach.

The following list embraces only the more common poisons, together with such antidotes as are usually at hand, to be used until the physician arrives.

Acids.—*Hydrochloric acid*, *muriatic acid* (spirits of salt), *nitric acid* (aqua fortis), *sulphuric acid* (oil of vitriol).

ANTIDOTE.—An antidote should be given at once to neutralize the acid. Strong soapsuds make an efficient remedy, and can always be obtained. It should be followed by copious draughts of warm water or flaxseed tea. Chalk, magnesia, soda or saleratus (with water), and lime-water, are the best remedies. When sulphuric acid has been taken, water should be given sparingly, because when water unites with this acid intense heat is produced.

Oxalic acid.

ANTIDOTE.—Oxalic acid resembles Epsom-salt in appearance, and may easily be mistaken for it. The antidotes are magnesia or chalk mixed with water.

Prussic Acid, *oil of bitter almonds*, *laurel water*, *cyanide of potassium* (used in electrotyping).

ANTIDOTE.—Cold douche to the spine. Chlorine water, or water of ammonia largely diluted, should be given, and the vapor arising from it inhaled.

Alkalies and their Salts.—AMMONIA (hartshorn), *liquor or water of ammonia.* POTASSA—*caustic potash*, *strong lye*, *carbonate of potassa* (pearlash), *nitrate of potassa* (saltpeter).

ANTIDOTE.—Give the vegetable acids diluted, as weak vinegar ;

acetic, citric, or tartaric acids dissolved in water. Castor-oil, linseed-oil, and sweet oil may also be used; they form soaps when mixed with the free alkalies, which they thus render harmless. The poisonous effects of saltpeter must be counteracted by taking mucilaginous drinks freely, so as to produce vomiting.

Alcohol.—*Brandy, wine; all spirituous liquors.*

ANTIDOTE.—Give as an emetic ground mustard or tartar emetic. If the patient cannot swallow, introduce a stomach-pump; pour cold water on the head.

Gases.—*Chlorine, carbonic-acid gas, carbonic oxide, fumes of burning charcoal, sulphuretted hydrogen, illuminating or coal gas.*

ANTIDOTE.—For poisoning by chlorine, inhale, cautiously, ammonia (hartshorn). For the other gases, cold water should be poured upon the head, and stimulants cautiously administered; artificial respiration. (See *Marshall Hall's Ready Method*, page 135.)

Metals.—*Antimony, tartar emetic, wine of antimony*, etc.

ANTIDOTE.—If vomiting has not occurred, it should be produced by tickling the throat with the finger or a feather, and the abundant use of warm water. Astringent infusions, such as common tea, oak bark, and solution of tannin, act as antidotes.

Arsenic.—*White arsenic, Fowler's solution, fly-powder, cobalt, Paris green*, etc.

ANTIDOTE.—Produce vomiting at once with a table-spoonful or two of powdered mustard in a glass of warm water, or with ipecac. The antidote is hydrated peroxide of iron. If Fowler's solution has been taken, lime-water must be given.

Copper.—*Acetate of copper* (verdigris), *sulphate of copper* (blue vitriol), food cooked in dirty *copper vessels*, or pickles made green by *copper*.

ANTIDOTE.—Milk or white of eggs, with mucilaginous drinks (flaxseed tea, etc.), should be freely given.

Iron.—*Sulphate of iron* (copperas), etc.

Antidote.—Carbonate of soda in some mucilaginous drink, or in water, is an excellent antidote.

Lead.—*Acetate of lead* (sugar of lead), *carbonate of lead* (white lead), water kept in *leaden pipes* or *vessels*, food cooked in *vessels* glazed with *lead*.

Antidote.—Induce vomiting with ground mustard or common salt in warm water. The antidote for soluble preparations of lead is Epsom-salts ; for the insoluble forms, sulphuric acid largely diluted.

Mercury.—*Bichloride of mercury* (corrosive sublimate), *ammoniated mercury* (white precipitate), *red oxide of mercury* (red precipitate), *red sulphuret of mercury* (vermilion).

Antidote.—The white of eggs, or wheat flour beaten up with water and milk, is the best antidote.

Silver.—*Nitrate of silver* (lunar caustic).

Antidote.—Give a tea-spoonful of common salt in a tumbler of water. It decomposes the salts of silver and destroys their activity.

Zinc.—*Sulphate of zinc*, etc. (white vitriol).

Antidote.—The vomiting may be relieved by copious draughts of warm water. The antidote is carbonate of soda administered in water.

Narcotic Poisons.—*Opium* (laudanum, paregoric, salts of morphia, Godfrey's cordial, Dalby's carminative, soothing syrup, cholera-mixtures), *aconite*, *belladonna*, *hemlock*, *stramonium*, *digitalis*, *tobacco*, *hyoscyamus*, *nux vomica*, *strychnine*.

Antidote.—Empty the stomach by the most active emetics, as mustard, alum, or sulphate of zinc. The patient should be kept in motion, and cold water dashed on the head and shoulders. Strong coffee must be given. The physician will use the stomach-pump and electricity. In poisoning by nux vomica or strychnine, etc., chloroform or ether should be inhaled to quiet the spasms.

Irritant Vegetable Poisons.—*Croton-oil*, *oil of savine*, *poke*, *oil of tansy*, etc.

Antidote.—If vomiting has taken place, it may be rendered

easier by copious draughts of warm water. But if symptoms of insensibility have come on without vomiting, it ought to be immediately excited by ground mustard mixed with warm water, or some other active emetic, and after its operation an active purgative should be given. After expelling as much of the poison as possible, strong coffee or vinegar and water may be given with advantage.

Poisonous Fish.—*Conger eel*, *mussels*, *crabs*, etc.

ANTIDOTE.—Evacuate, as soon as possible, the contents of the stomach and bowels by emetics (ground mustard mixed with warm water or powdered alum), and castor-oil, drinking freely at the same time of vinegar and water. Ether, with a few drops of laudanum mixed with sugar and water, may afterward be taken freely.

Poisonous Serpents.—ANTIDOTE.—A ligature or handkerchief should be applied moderately tight above the bite, and a cupping-glass over the wound. The patient should drink freely of alcoholic stimulants containing a small quantity of ammonia. The physician may inject ammonia into the veins.

Poisonous Insects.—*Stings of scorpion*, *hornet*, *wasp*, *bee*, etc.

ANTIDOTE.—A piece of rag moistened with a solution of carbolic acid may be kept on the affected part until the pain is relieved ; and a few drops of carbolic acid may be given frequently in a little water. The sting may be removed by making strong pressure around it with the barrel of a small watch-key.

GLOSSARY.

Ab-do'men (Latin *abdo*, to conceal). The largest cavity of the body, containing the liver, stomach, intestines, etc.; the belly.

Ab-sor'bents (L. *ab* and *sorbeo*, to suck from). The vessels which take part in the process of absorption.

Ab-sorp'tion. The process of sucking up fluids by means of an animal membrane.

Ac-com-mo-da'tion of the Eye. The alteration in the shape of the crystalline lens, which accommodates or adjusts the eye for near and remote vision.

Al-bu'men, or Albumin (L. *albus*, white). An animal substance resembling white of egg.

Al-bu'mi-nose (from *albumen*). A soluble animal substance produced in the stomach by the digestion of the albuminoid substances.

Al-bu'min-oid substances. A class of proximate principles resembling albumen; they may be derived from either the animal or vegetable kingdoms.

Al-i-ment'a-ry Ca-nal (from *alo*, to nourish). A long tube in which the food is digested, or prepared for reception into the system.

A-or'ta (Gr. *ἀορτέομαι*, *aorteomai*, to be lifted up). The largest artery of the body, and main trunk of all the arteries. It arises from the left ventricle of the heart. The name was first applied to the two large branches of the trachea, which appear to be lifted up by the heart.

Ar'tery (Gr. *ἀήρ*, *aer*, air, and *τηρεῖν*, *terein*, to contain). A vessel by which blood is conveyed away from the heart. It was supposed by the ancients to contain air; hence the name.

A-ryt'e-noid Car'ti-la-ges (Gr. *ἀρύταινα*, *arutaina*, a pitcher). Two small cartilages of the larynx, resembling the mouth of a pitcher.

As-sim-i-la'tion (L. *ad*, to, and *similis*, like). The conversion of food into living tissue.

AU'DI-TO-RY NERVE. One of the cranial nerves; it is the special nerve of hearing.

AU'RI-CLE (L. *auris*, the ear). A cavity of the heart.

BAR'I-TONE (Gr. βαρύς, *barus*, heavy, and τόνος, *tonos*, tone). A variety of male voice between the bass and tenor.

BI-CUS'PID (L. *bi*, two, and *cuspis*, prominence). The name of the fourth and fifth teeth on each side of the jaw; possessing two prominences.

BILE. The gall, or peculiar secretion of the liver; a viscid, yellowish fluid, and very bitter to the taste.

BRONCH'I-AL TUBES. The smaller branches of the trachea within the substance of the lungs, terminating in the air-cells.

CA-NAL' (L.). In the body, any tube or passage.

CA-NINE' (L. *canis*, a dog). Name given to the third tooth on each side of the jaw; in the upper jaw, pointed like the tusks of a dog, it is also known as the eye-tooth.

CAP'IL-LA-RY (L. *capil'la*, a hair, *capilla'ris*, hair-like). The name of the extremely minute blood-vessels which connect the arteries with the veins.

CAR'BON DIOX-IDE (CO_2). Chemical name for carbonic acid gas.

CAR-BON'IC A'CID. The gas which is present in the air expired from the lungs; a waste product of the animal kingdom, and a food of the vegetable kingdom.

CAR'DI-AC (Gr. καρδια, *cardia*, the heart). The cardiac orifice of the stomach is the upper one, and is near the heart; hence its name.

CAR'TI-LAGE. A solid but flexible material, forming a part of the joints, air-passages, nostrils, ear; gristle.

CER-E-BEL'LUM (diminutive for *cer'ebrum*, the brain). The little brain, situated beneath the posterior third of the cerebrum.

CER'E-BRUM (L.). The brain proper, occupying the entire upper portion of the skull. It is nearly divided into two equal parts, called "hemispheres," by a cleft extending from before backward.

CHO'ROID (Gr. χόριον, *chorion*, a membrane or covering). The middle tunic or coat of the eyeball.

CHYLE (Gr. χυλός, *chulos*, juice). The milk-like fluid formed by the digestion of fatty articles of food in the intestines.

CHYME (Gr. χυμός, *chumos*, juice). The pulpy liquid formed by digestion within the stomach.

CIL'I-A (pl. of *cil'i-um*, an eyelash). Minute, vibratile, hair-like processes found upon the cells of the air-passages, and other parts that are habitually moist.

CIR-CU-LA'TION (L. *cir'culus*, a ring). The circuit, or course of the blood through the blood-vessels of the body, from the heart to the arteries, through the capillaries into the veins, and from the veins back to the heart.

CO-AG-U-LA'TION (L. *coag'ulo*, to curdle). Applied to the process by which the blood clots or solidifies.

CON-VO-LU'TIONS (L. *con* and *vol'vo*, to roll together). The tortuous foldings of the external surface of the brain.

COR'NE-A (L. *cor'nu*, a horn). The transparent, horn-like substance which covers the anterior fifth of the eyeball.

COR'PUS-CLES, BLOOD (L. dim. of *cor'pus*, a body). The small bi-concave disks which give to the blood its red color; the *white* corpuscles are globular and larger.

CRA'NI-AL (L. *cra'nium*, the skull). Pertaining to the skull. The nerves which arise from the brain are called cranial nerves.

CRYS'TAL-LINE LENS (L. *crystal'lum*, a crystal). One of the so-called humors of the eye; a double convex body situated in the front part of the eyeball.

CU'TI-CLE (L. dim. of *cu'tis*, the skin). The scarf-skin; also called the *epider'mis*.

CU'TIS (Gr. σκῦτος, *skutos*, a skin or hide). The true skin, lying beneath the cuticle; also called the *der'mis*.

DI'A-PHRAGM (Gr. διαφράσσω, *diaphrasso*, to divide by a partition). A large, thin muscle which separates the cavity of the chest from the abdomen; a muscle of respiration.

DUCT (L. *du'co*, to lead). A narrow tube; the *thoracic duct* is the main trunk of the absorbent vessels.

DYS-PEP'SI-A (Gr. δυς, *dus*, difficult, and πεπτω, *pepto*, to digest). Difficult or painful digestion; a disordered condition of the stomach.

E-MUL'SION (L. *emul'geo*, to milk). Oil in a finely divided state suspended in water.

EN-AM'EL (Fr. *email*). The dense material which covers the crown of the tooth.

EP-I-GLOT'TIS (Gr. ἐπί, *epi*, upon, and γλῶττις, *glottis*, the entrance to the windpipe). A leaf-shaped piece of cartilage which covers the top of the larynx during the act of swallowing.

EX-CRE'TION (L. *excer'no*, to separate). The separation from the blood of the waste particles of the body; also the materials excreted.

Ex-pi-ra'tion (L. *expi'ro,* to breathe out). The act of forcing air out of the lungs.

Ex-ten'sion (L. *ex,* out, and *ten'do,* to stretch). The act of restoring a limb, etc., to its natural position after it has been flexed, or bent; the opposite of *Flexion.*

Fi'brin (L. *fi'bra,* a fiber). An albuminoid substance found in the blood; in coagulating it assumes a fibrous form.

Flex'ion (L. *flecto,* to bend). The act of bending a limb, etc.

Gan'gli-on (Gr. *γάνγλίον, ganglion,* a knot). A knot-like swelling in the course of a nerve; a smaller nerve-centre.

Gas'tric (Gr. *γαστήρ, gaster,* stomach). Pertaining to the stomach.

Gland (L. *glans,* an acorn). An organ consisting of follicles and ducts, with numerous blood-vessels interwoven; it separates some particular fluid from the blood.

Hem'i-spheres (Gr. *σφαῖρα, sphaira,* a sphere). Half a sphere, the lateral halves of the cerebrum, or brain proper.

Hy'gi-ene (Gr. *ὑγίεια, hugieia,* health). The art of preserving health and preventing disease.

In-ci'sor (L. *inci'do,* to cut). Applied to the four front teeth of both jaws, which have sharp cutting edges.

In'cus (L.). An anvil; the name of one of the bones of the middle ear.

In-sal-i-va'tion (L. *in,* and *sali'va,* the fluid of the mouth). The mingling of the saliva with the food during the act of chewing.

In-spi-ra'tion (L. *in,* and *spi'ro,* to breathe). The act of drawing in the breath.

In-teg'u-ment (L. *in,* and *te'go,* to cover). The skin, or outer covering of the body.

In-tes'tine (L. *in'tus,* within). The part of the alimentary canal which is continuous with the lower end of the stomach; also called the intestines, or the bowels.

I'ris (L. *i'ris,* the rainbow). The thin muscular ring which lies between the cornea and crystalline lens, and which gives the eye its brown, blue, or other color.

Ju'gu-lar (L. *ju'gulum,* the throat). The name of the large veins which run along the front of the neck.

Lab'y-rinth (Gr. *λαβύρινθος, laburin'thos,* a building with many winding passages). The very tortuous cavity of the inner ear, comprising the vestibule, semicircular canals, and the cochlea.

Lach'ry-mal Apparatus (L. *lach'ryma,* a tear). The organs for forming and conveying away the *tears.*

LAC'TE-ALS (L. *lac, lac'tis,* milk). The absorbent vessels of the small intestines; during digestion they are filled with chyle, which has a milky appearance.

LAR'YNX (Gr.). The cartilaginous tube situated at the top of the windpipe, or trachea; the organ of the voice.

LENS (L.). Literally, a lentil; a piece of transparent glass or other substance so shaped as either to converge or disperse the rays of light.

LIG'A-MENT (L. *li'go,* to bind). A strong fibrous material binding bones or other solid parts together; it is especially necessary to give strength to joints.

MAL'LE-US (L.). Literally, the mallet; one of the small bones of the middle ear.

MAR'ROW. The soft, fatty substance contained in the central cavities of the bones: the spinal marrow, however, is composed of nervous tissue.

MAS-TI-CA'TION (L. *mas'tico,* to chew). The act of cutting and grinding the food to pieces by means of the teeth.

ME-DUL'LA OB-LON-GA'TA. The "oblong marrow," or nervous cord, which is continuous with the spinal cord within the skull.

MEM'BRANE. A thin layer of tissue serving to cover some part of the body.

MI'CRO-SCOPE (Gr. *μικρός, mikros,* small, and *σκοπέω, skopeo,* to look at). An optical instrument which assists in the examination of minute objects.

MO'LAR (L. *mo'la,* a mill). The name applied to the three back teeth of each side of the jaw; the grinders, or mill-like teeth.

MU'COUS MEMBRANE. The thin layer of tissue which covers those internal cavities or passages which communicate with the external air.

MU'CUS. The glairy fluid which is secreted by mucous membranes, and which serves to keep them in a moist condition.

NA'SAL (L. *na'sus,* the nose). Pertaining to the nose; the *nasal cavities* contain the distribution of the special nerve of smell.

NERVE (Gr. *νεῦρον, neuron,* a cord or string). A glistening, white cord of cylindrical shape, connecting the brain or spinal cord with some other organ of the body.

NERVE-CELL. A minute, round, and ashen-gray cell found in the brain and other nervous centres.

NERVE FI'BER. An exceedingly slender thread of nervous tissue

found in the various nervous organs, but especially in the nerves; it is of a white color.

NU-TRI'TION (L. *nu'trio*, to nourish). The processes by which the nourishment of the body is accomplished.

Œ-SOPH'A-GUS (Gr.). Literally, that which carries food. The tube leading from the throat to the stomach; the gullet.

OP'TIC (Gr. ὄπτω, *opto*, to see). Pertaining to the sense of sight.

OR'BIT (L. *or'bis*, the socket). The bony socket or cavity in which the eyeball is situated.

PAL'ATE (L. *pala'tum*, the palate). The roof of the mouth, consisting of the hard and soft palate.

PAN'CRE-AS (Gr. πᾶς, παντός, *pas, pantos*, all, and κρέας, *kreas*, flesh). A long, flat gland situated near the stomach; in the lower animals the analogous organ is called the sweet-bread.

PA-PIL'LÆ (L. pl. of *papil'la*). The minute prominences in which terminate the ultimate fibres of the nerves of touch and taste.

PA-RAL'Y-SIS. A disease of the nervous system marked by the loss of sensation, or voluntary motion, or both; palsy.

PER-I-CAR'DIUM (Gr. περί, *peri*, about, and κάρδια, *kardia*, heart). The sac enclosing the heart.

PER-SPI-RA'TION (L. *perspi'ro*, to breathe through). The sweat, or watery exhalation of the skin; when visible, it is called *sensible* perspiration, when invisible, it is called *insensible* perspiration.

PHAR'YNX (Gr. φάρυνξ, *pharunx*, the throat). The cavity between the back of the mouth and gullet.

PHYS-I-OL'O-GY (Gr. φύσις, *phusis*, nature, and λόγος, *logos*, a discourse). The science of the functions of living, organized beings.

PUL'MO-NA-RY (L. *pul'mo, pulmo'nis*, the lungs). Pertaining to the lungs.

PULSE (L. *pel'lo, pul'sum*, to beat). The striking of an artery against the finger, occasioned by the contraction of the heart, commonly felt at the wrist.

PU'PIL (L. *pupil'la*). The central, round opening in the iris, through which light passes into the depths of the eye.

PY-LO'RUS (L. πυλωρός, *puloros*, a gate-keeper). The lower opening of the stomach, at the beginning of the small intestine.

RE'FLEX ACTION. An involuntary action of the nervous system, by which an external impression conducted by a sensory nerve is reflected or converted into a motor impulse.

RES-PI-RA'TION (L. *res'piro*, to breathe frequently). The function of

breathing, comprising two acts: *inspiration*, or breathing in, and *expiration*, or breathing out.

RET'INA (L. *re'te*, a net). The innermost of the three tunics or coats of the eyeball, being an expansion of the optic nerve.

SAC'CHA-RINE (L. *sac'charum*, sugar). Of the nature of sugar; applied to the important group of food substances which embraces the different varieties of sugar, starch, and gum.

SA-LI'VA (L.). The moisture or fluids of the mouth, secreted by the salivary glands, etc.

SE-CRE'TION (L. *secer'no, secre'tum*, to separate). The process of separating from the blood some essential important fluid; which fluid is also called a secretion.

SEN-SA'TION. The perception of an external impression by the nervous system; a function of the brain.

SEN-SI-BIL'I-TY, GENERAL. The power possessed by nearly all parts of the human body of recognizing the presence of foreign objects that come in contact with them.

SE'RUM (L.). The watery constituent of the blood, which separates from the clot during the process of coagulation.

SKEL'E-TON (Gr.). The bony framework of an animal, the different parts of which are maintained in their proper relative positions.

STA'PES (L.). Literally, a stirrup; one of the small bones of the tympanum, or middle ear, resembling somewhat a stirrup in shape.

TEN'DON (L. *ten'do*, to stretch). The white, fibrous cord or band by which a muscle is attached to a bone; a sinew.

THO'RAX (Gr. θώραξ, *thorax*, a breast-plate). The upper cavity of the trunk of the body, containing the lungs, heart, etc.; the chest.

TRA'CHE-A (Gr. τραχύς, *trachus*, rough). The windpipe, or the largest of the air-passages; composed in part of cartilaginous rings, which render its surface rough and uneven.

TYM'PA-NUM (Gr. τυμπανον, *tumpanon*, a drum). The cavity of the middle ear, resembling a drum in being closed by two membranes, and in having communication with the atmosphere.

VE'NOUS (L. *ve'na*, a vein). Pertaining to, or contained within a vein.

VEN-TI-LA'TION. The introduction of fresh air into a room or building in such a manner as to keep the air within it in a pure condition.

VEN-TRIL'O-QUISM (L. *ven'ter*, the belly, and *lo'quor*, to speak). A modification of natural speech by which the voice is made to ap-

pear to come from a distance. The ancients supposed that the voice was formed in the belly; hence the name.

VEN'TRI-CLES of the heart. The two largest cavities of the heart, situated at its apex or point.

VER'TE-BRAL COLUMN (L. *ver'tebra,* a joint). The back-bone, consisting of twenty six separate bones, called vertebræ, firmly jointed together; also called the spinal column and spine.

VIL'LI (L. *vil'lus,* the nap of cloth). Minute thread-like projections found upon the internal surface of the small intestine, giving it a velvety appearance.

VOCAL CORDS. Two elastic bands or ridges situated in the larynx; they are the essential parts of the organs of the voice.

TOPICAL INDEX.

A COMPLETE [illegible]

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PHYSIOLOGY AND HYGIENE

BY

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